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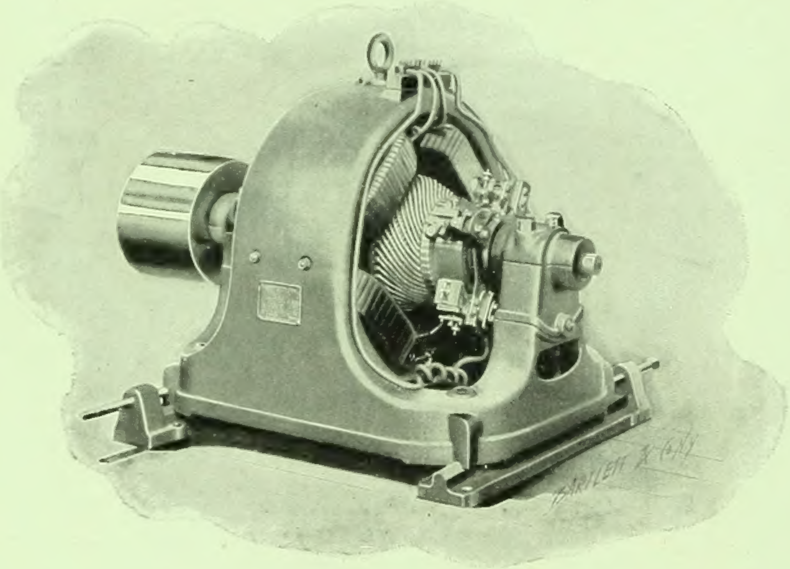

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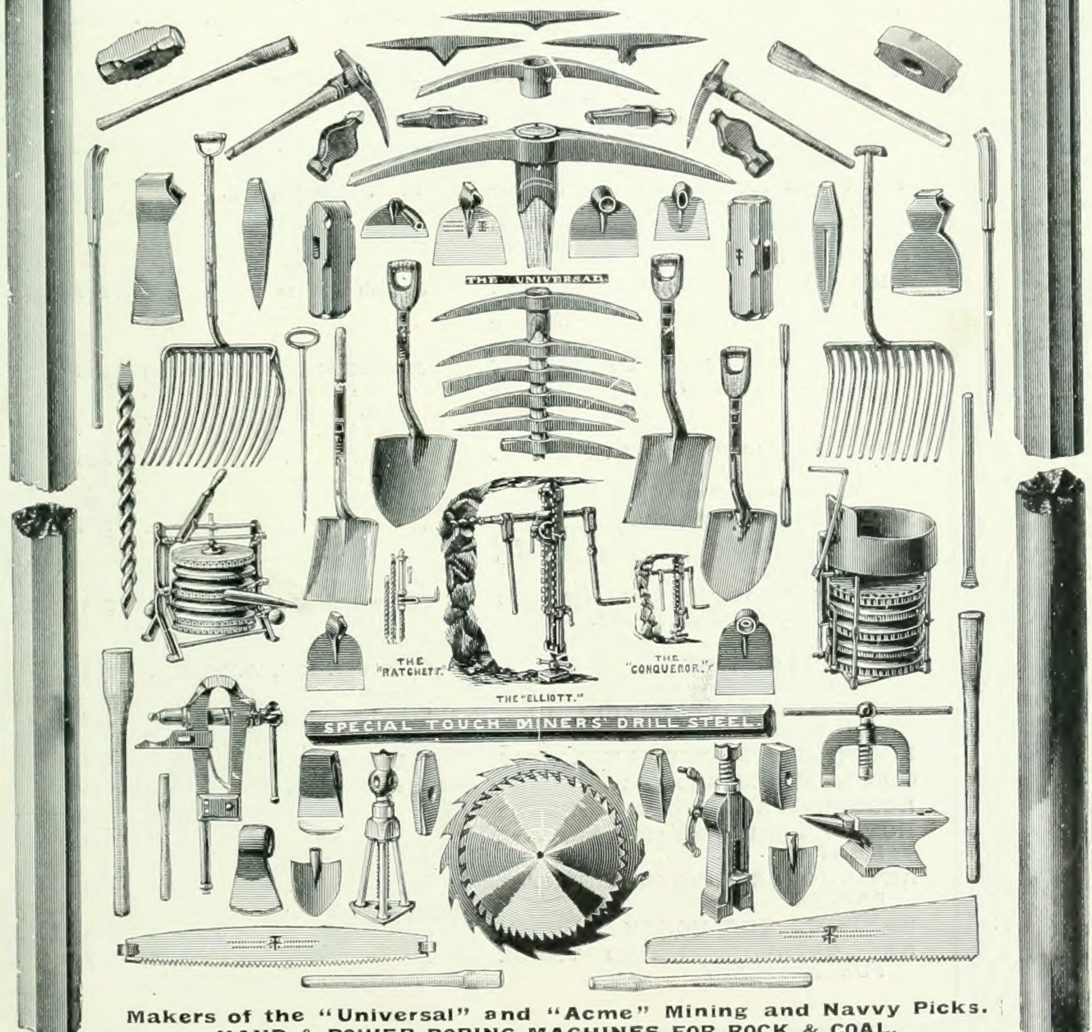
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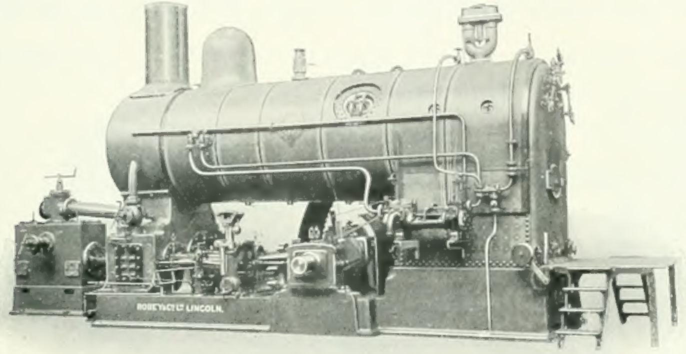

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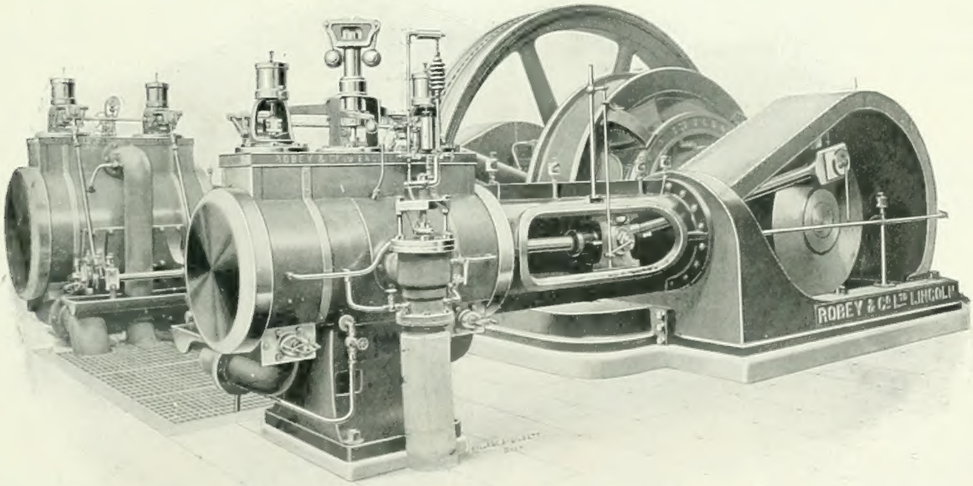

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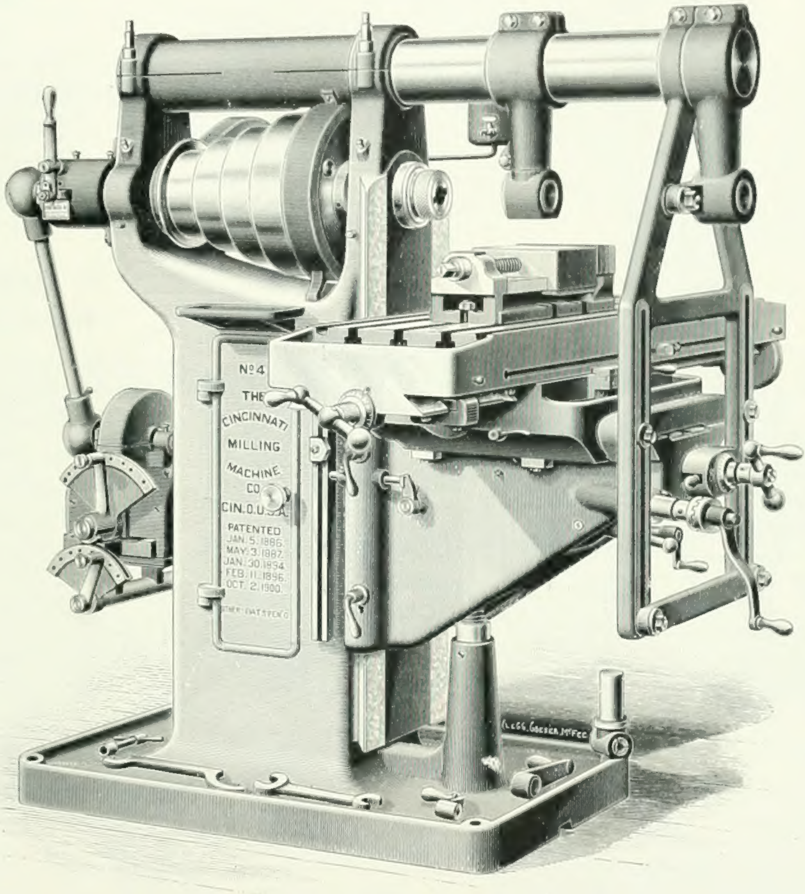

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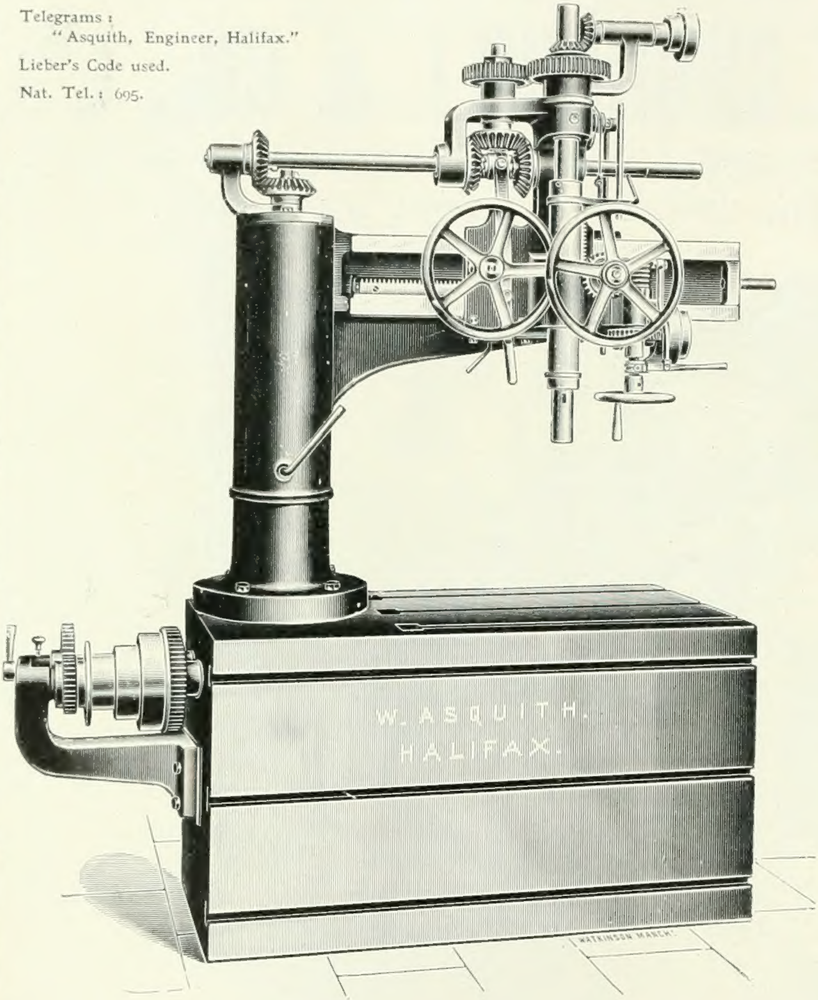
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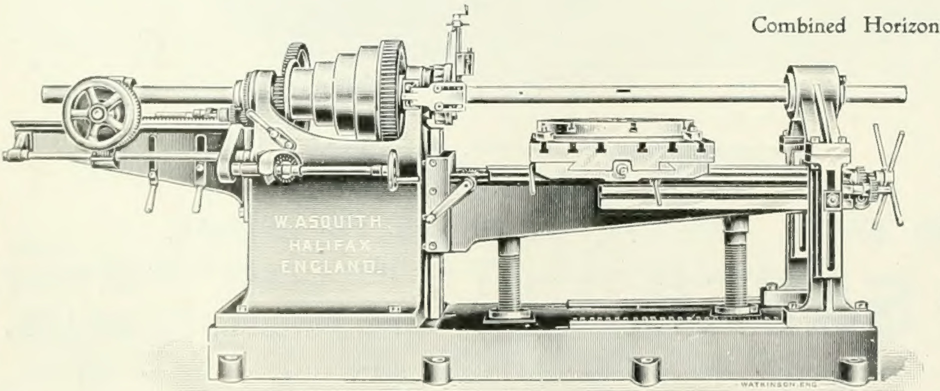

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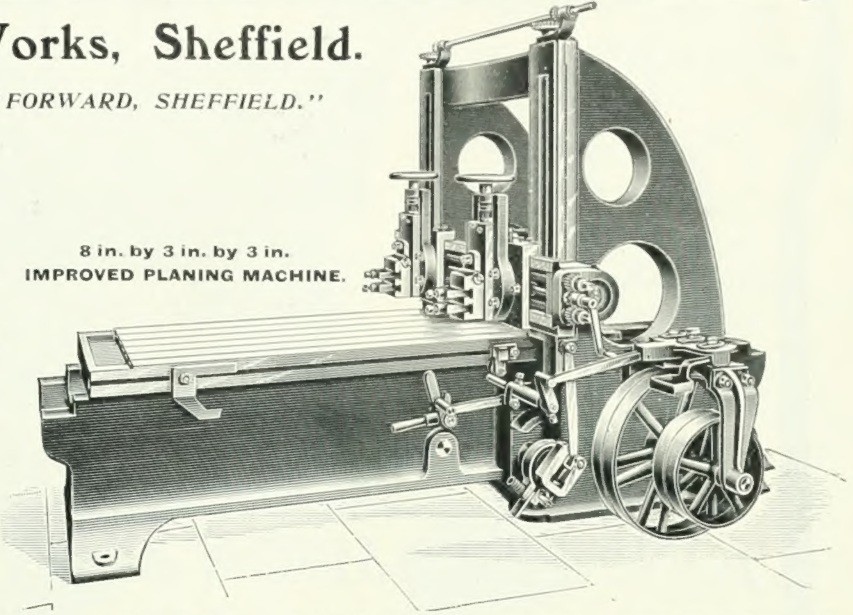

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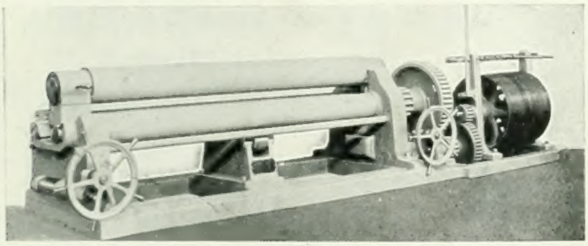

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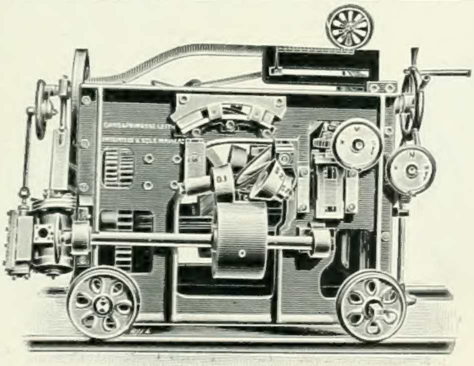

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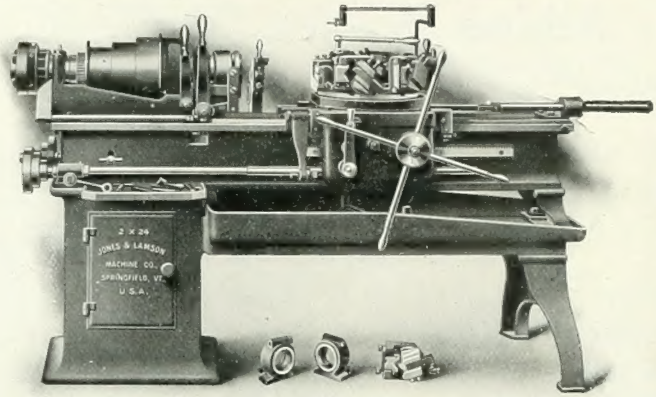

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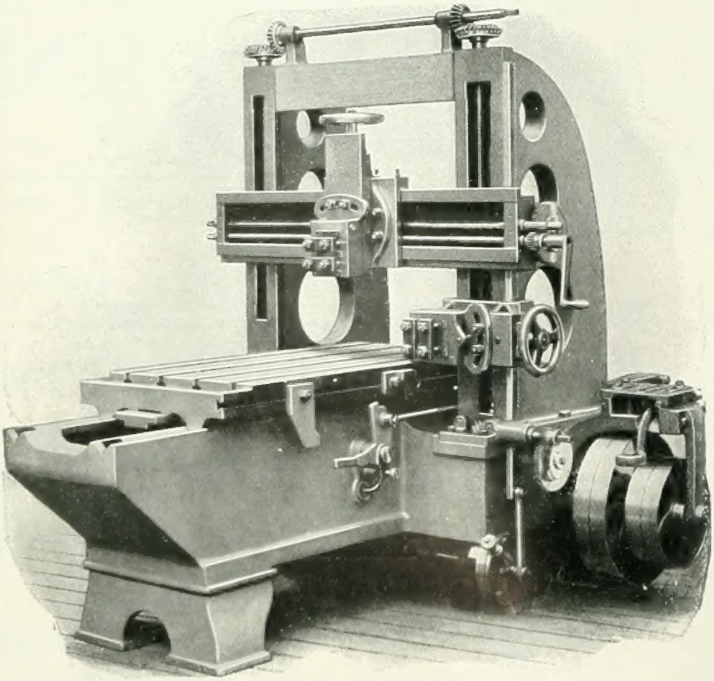

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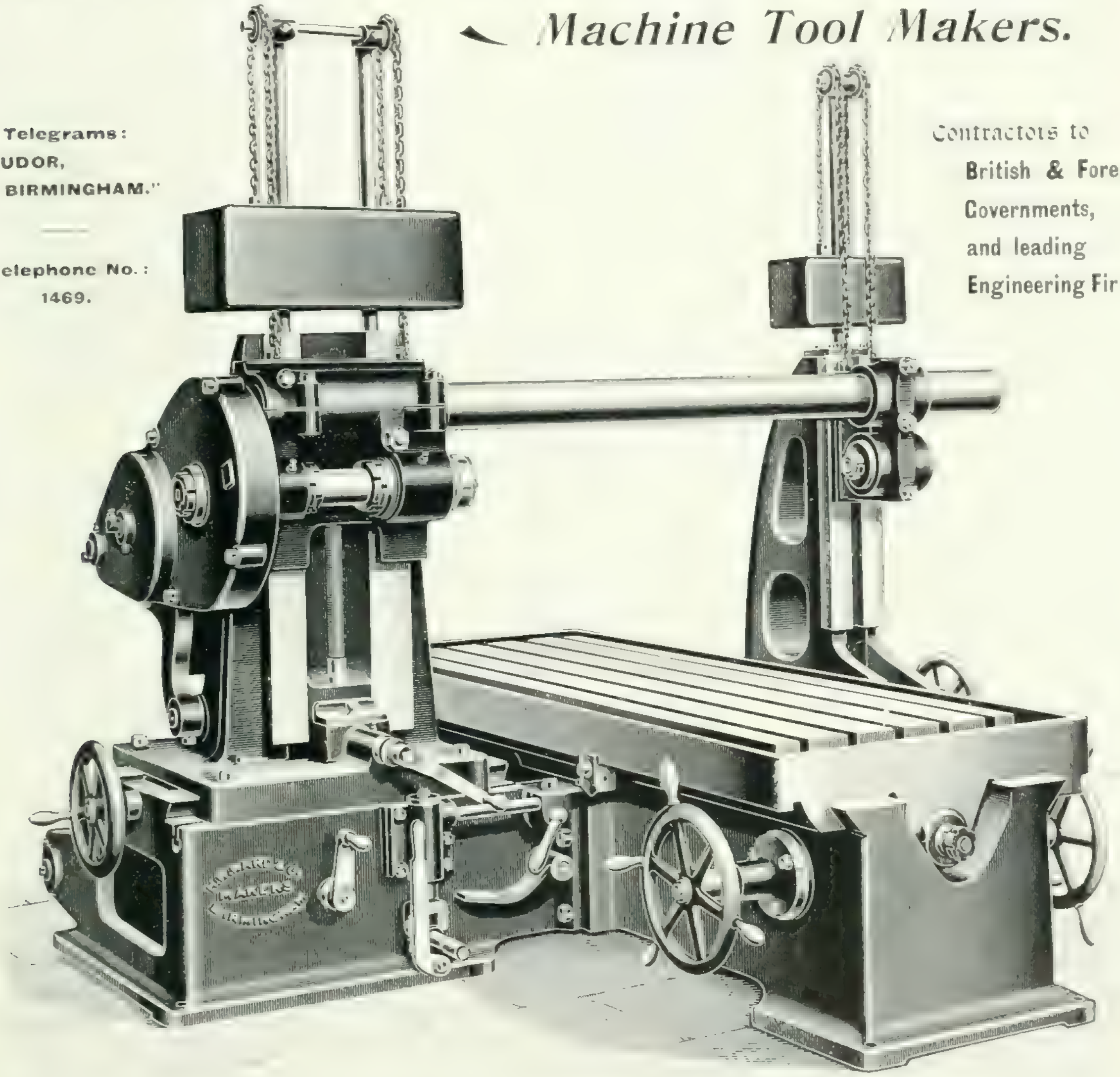

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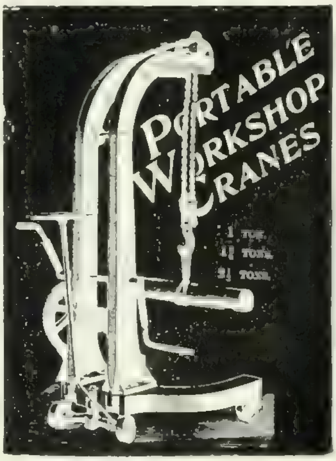
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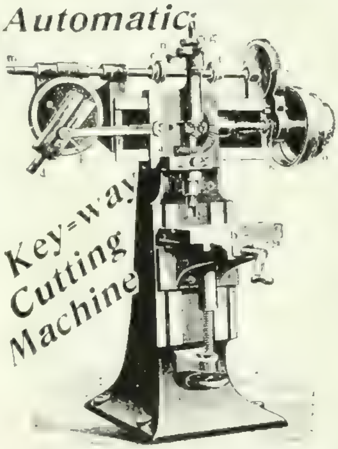

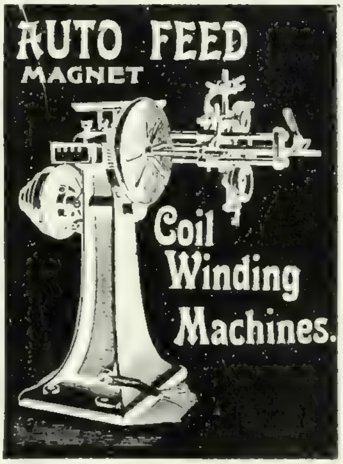

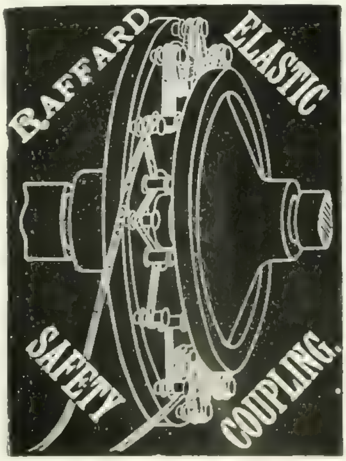

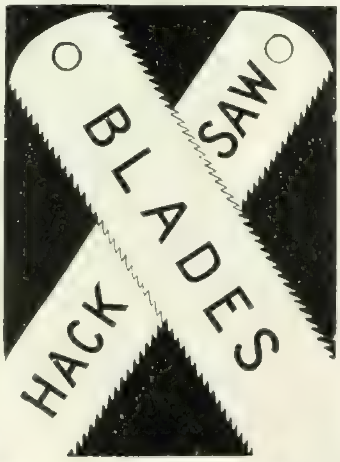

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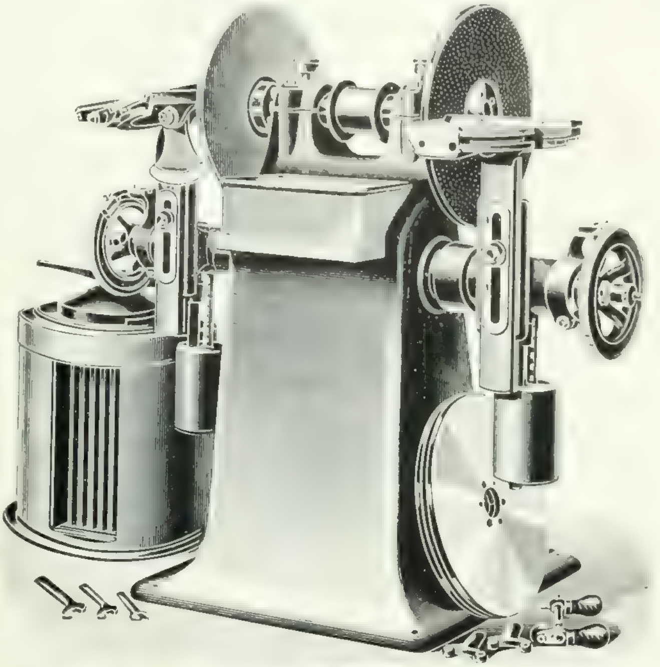

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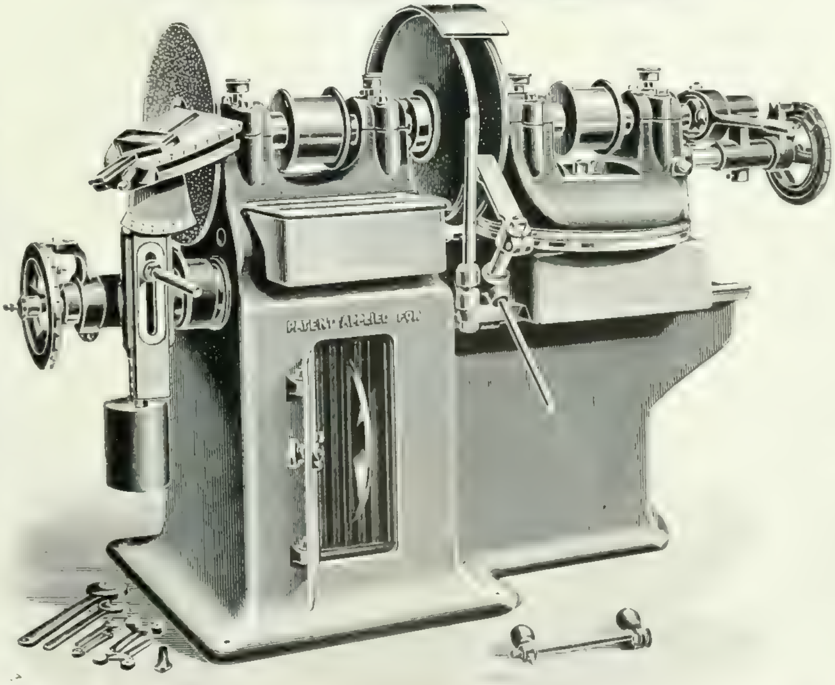

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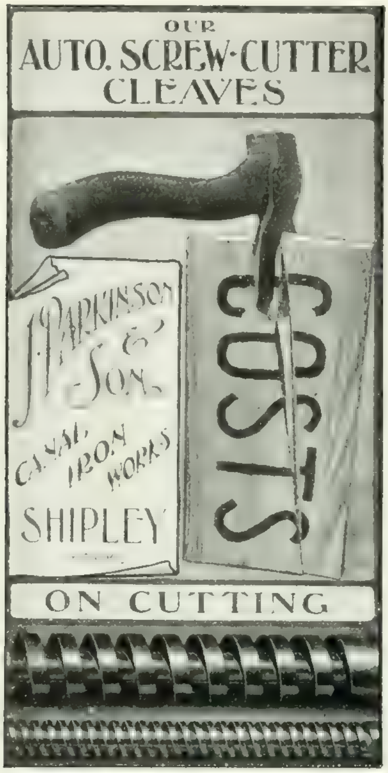

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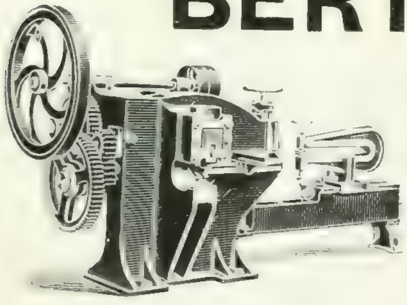

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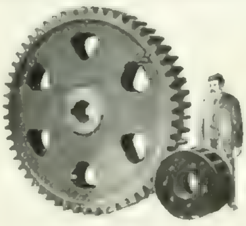

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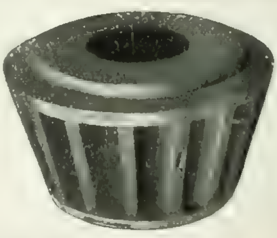

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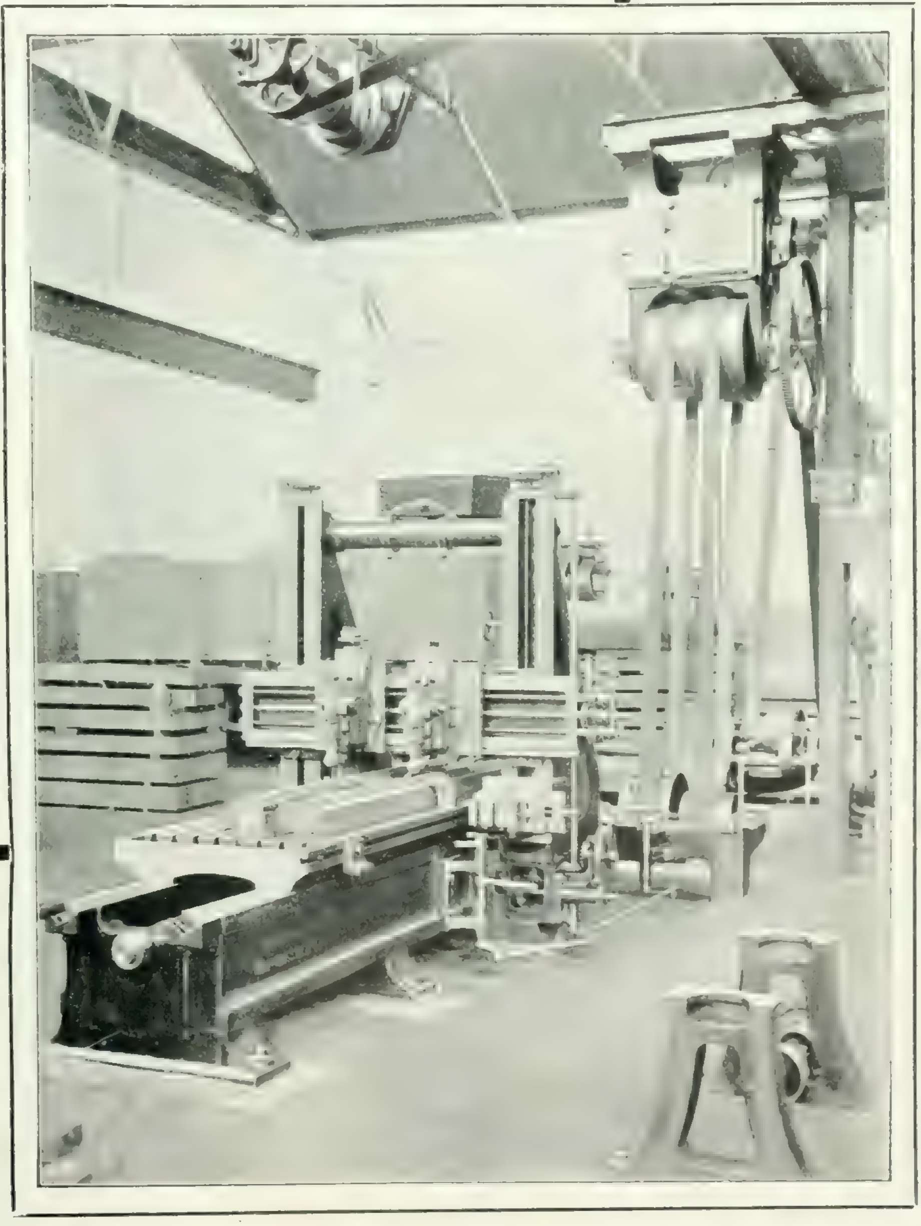

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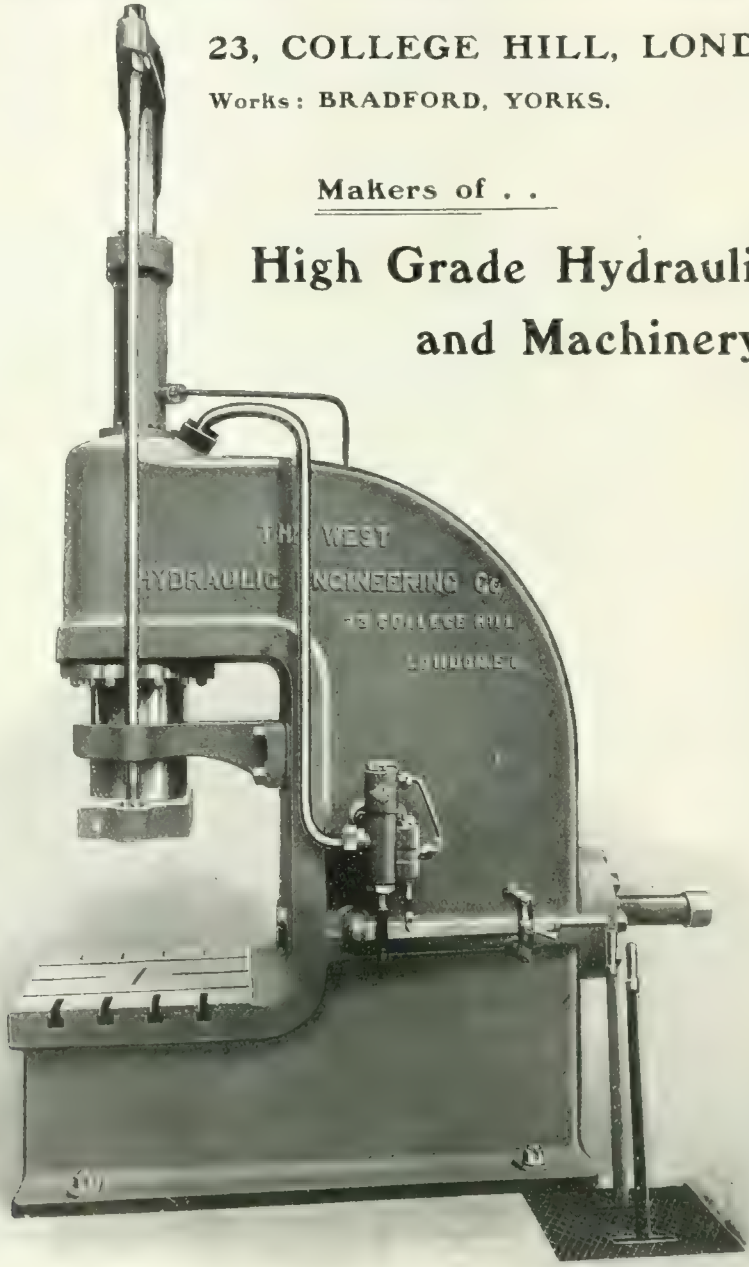

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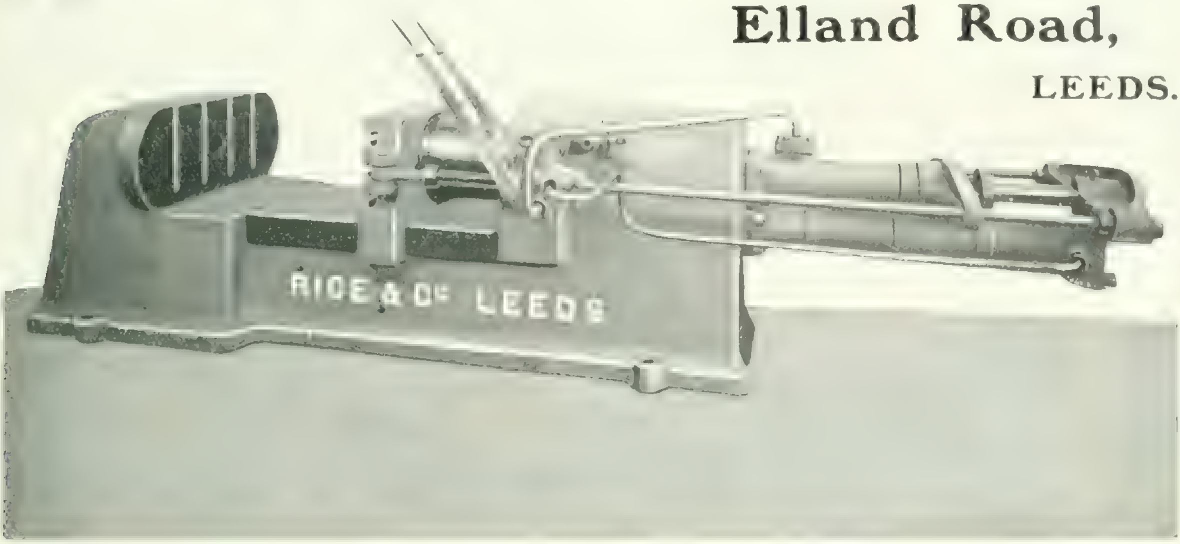

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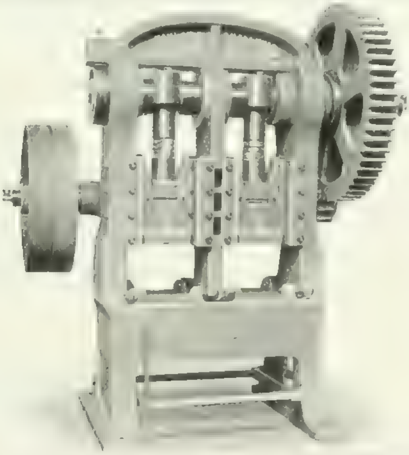

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Power Presses, Tools, Shears, and Lathes.

For Sheet Metal Drawing, Stamping, and Spinning, &c.
See accompanying illustration of our Double Crank Forging Press for Clipping Drop Forgings.

Press Tools.

For the production of Electric Light Fittings, Cycle, Motor, Dynamo, and Telephone parts.

Machinery.

For the production of Coins, Solid Drawn Cartridge Cases for Small Arms and Quick Firing Guns, Smokeless Powder, and Gun Cotton, &c.

THE

Jos. C. NICHOLSON TOOL Co.

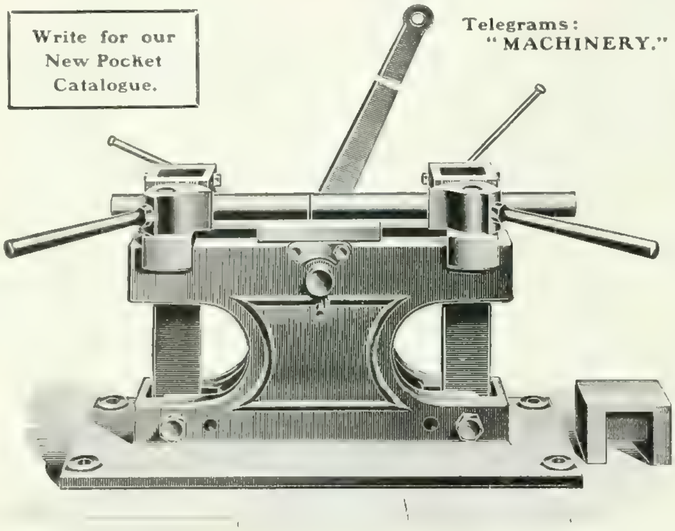
Engineers and Machine Tool Makers,

CITY ROAD TOOL WORKS,

NEWCASTLE-ON-TYNE.

Write for our
New Pocket
Catalogue.

Telegrams:
"MACHINERY."



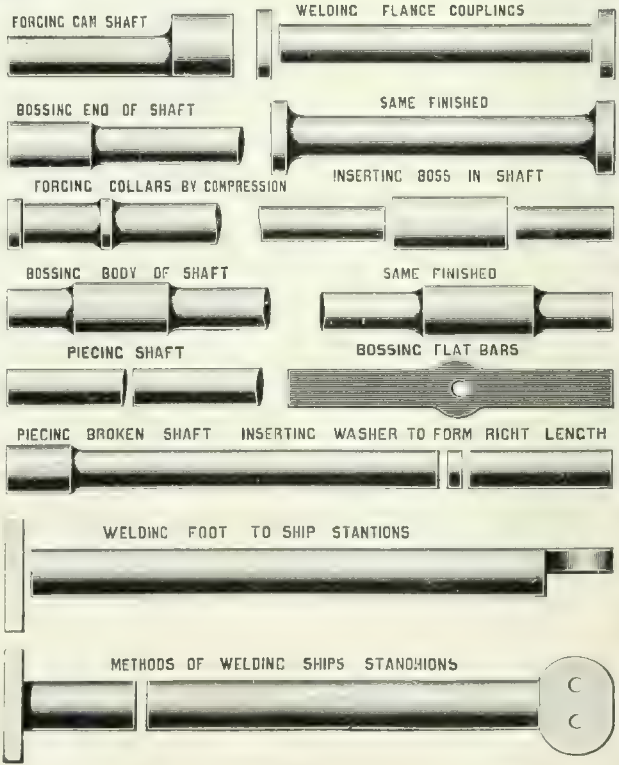
A LABOUR SAVER
for the
BLACKSMITH'S SHOP.

The "Standard" Hand Power

Welding & Forging Machine.

Two men can weld bars and shafts on this machine up to three inches diameter, and three men up to six inches diameter. One man on the lever gives a pressure on the bar of 20 tons, which can be utilised to compress collars and bosses in iron bars.

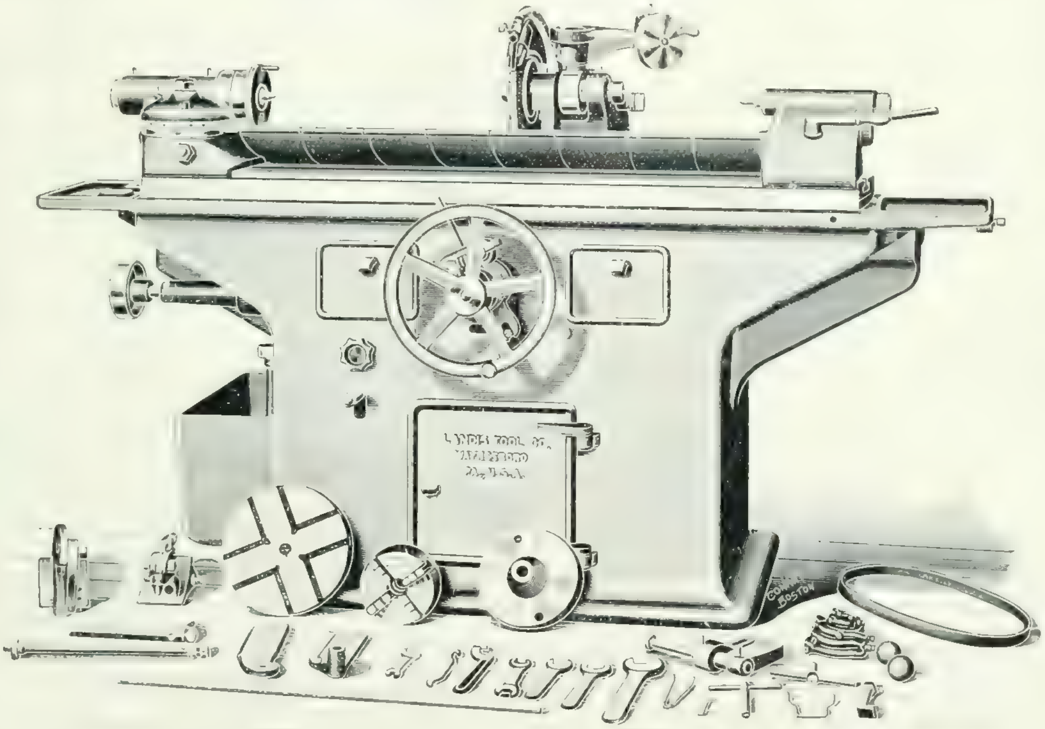
THE adjoining illustration shows samples of work which can be effectively and economically done on this machine, such as welding flange couplings on shafts, and the flats on to ships' stanchions. Bossing flat bars by compression, forming collars and bosses in round bars, inserting bosses of larger diameter, &c. No smith's shop is complete without this machine.



Landis Grinding Machines,

Plain and Universal.

ABSOLUTELY INDISPENSABLE IN THE MODERN TOOL ROOM.

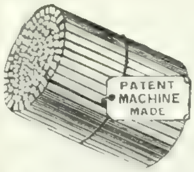


Designed for the accurate and rapid production of duplicate work formerly done on the lathe or milling machine. Made in 9 sizes, grinding from 10 to 20 in. diameter, and from 20 to 144 in. long.

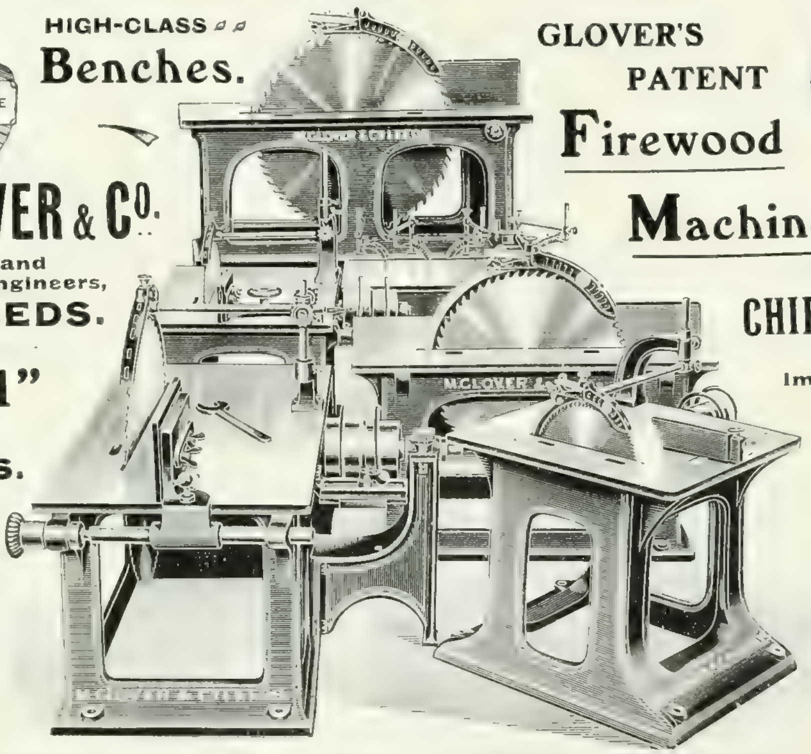
Further Particulars on application.

C. W. Burton, Griffiths & Co.

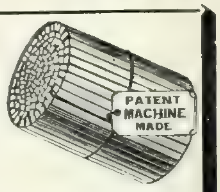
1, 2 & 3, Ludgate Square, Ludgate Hill, LONDON, E.C.
And at 59, Finmeston Street, GLASGOW.



HIGH-CLASS
Benches.



GLOVER'S
PATENT
Firewood
Machinery



M. GLOVER & Co.
Patentees and
Saw Mill Engineers,
LEEDS.

"Ideal"
SAW
GUARDS.

N.B.
"IDEAL" Saw Guards are giving the greatest satisfaction possible in many hundreds of leading works

THEY FIT
OTHERS
CAN NOT.

makes
CHIPS & MONEY

Improved Patent
SAW
SHARPENING
MACHINES.

Gold and other
Medals Awarded

Special Machines
designed for
Special Purposes.

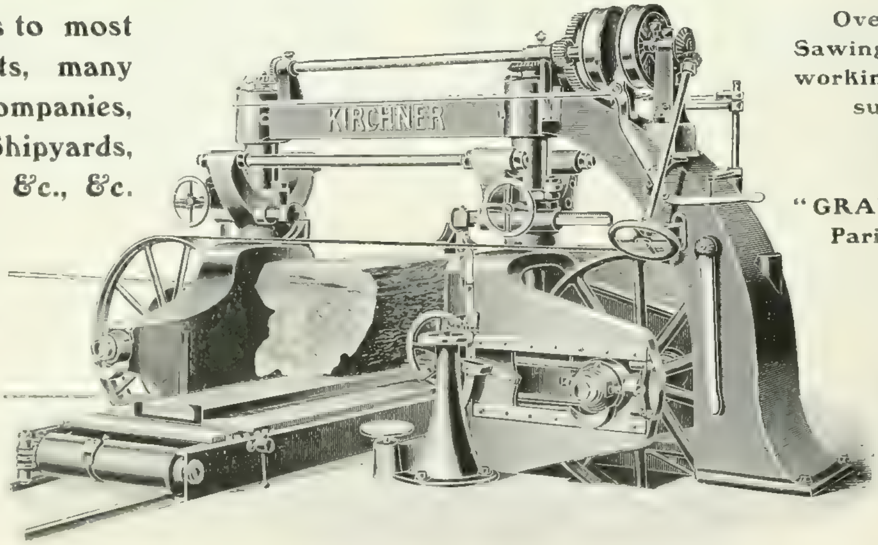
Circulars and
Particulars gladly
furnished upon
application.

Sawing & Woodworking Machinery.

Contractors to most
Governments, many
Railway Companies,
Collieries, Shipyards,
Dockyards, &c., &c.

Over 1,000
Workmen employed in
this
Department.

Catalogues and
Prices
on Application.



HEAVY LARGE PATENT HORIZONTAL BAND MILL

Over 70,000
Sawing & Woodworking Machines
supplied.

"GRAND PRIX,"
Paris, 1900.

Over 70 Gold
Medals
and other
Highest
Distinctions.

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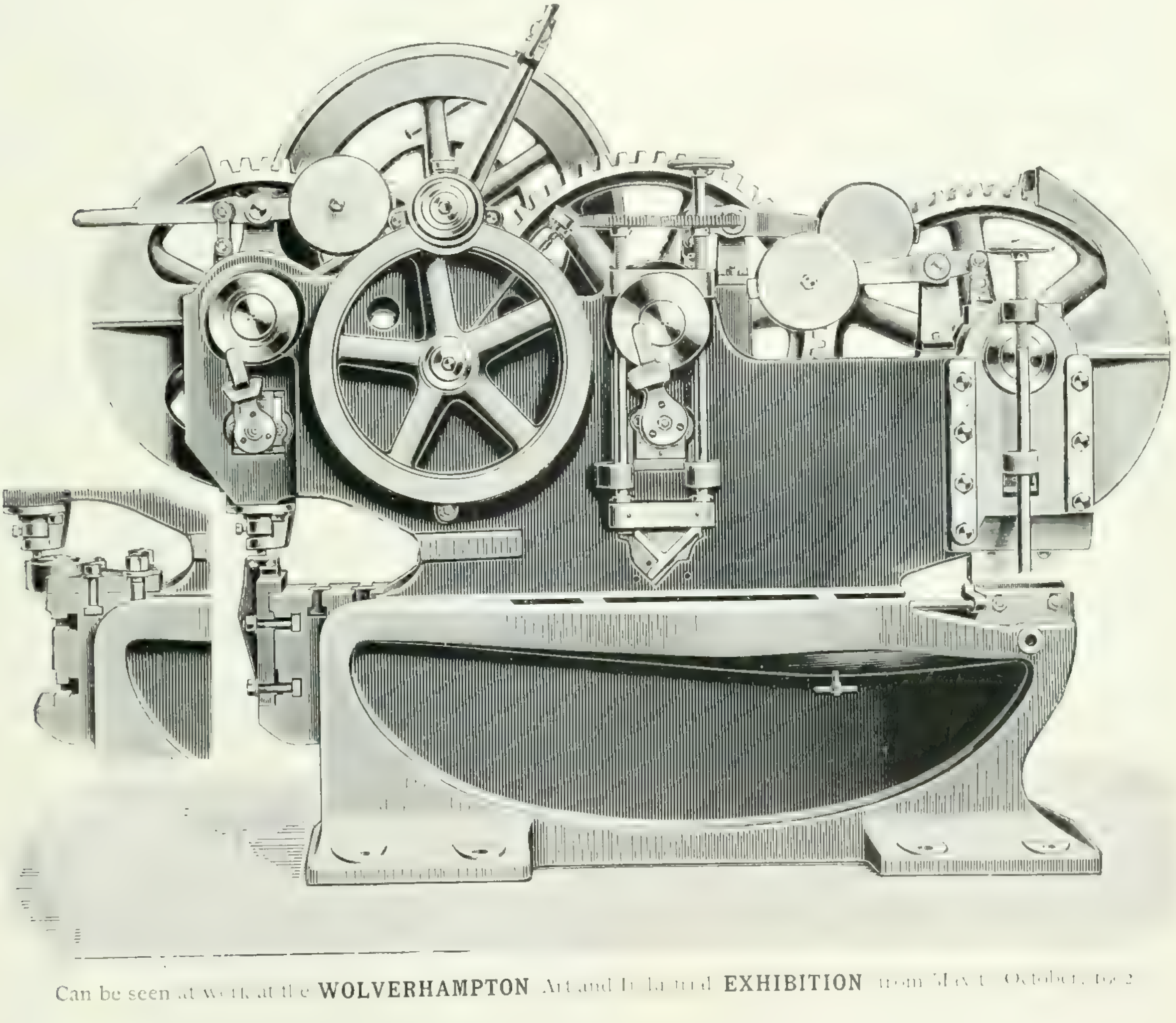
PATENT SHEARING

AND PUNCHING MACHINES

for shearing plates of UNLIMITED length and width.



Can be seen at work at the **WOLVERHAMPTON** Art and Industrial **EXHIBITION** from May to October, 1902

R. BECKER & CO.,

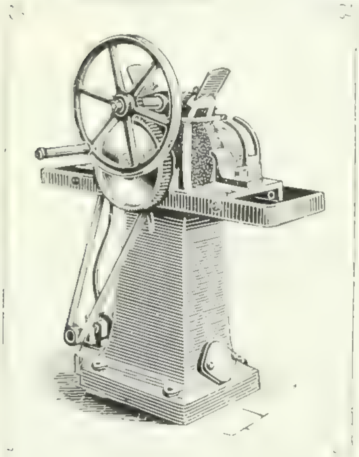
46, RIVINGTON STREET, OLD STREET, LONDON, E.C.

Luke & Spencer, Ltd.,

BROADHEATH,
MANCHESTER.

Telegraphic Address
"Emery, Altrincham."
National Telephone
"Altrincham 49."

Manufacturers of

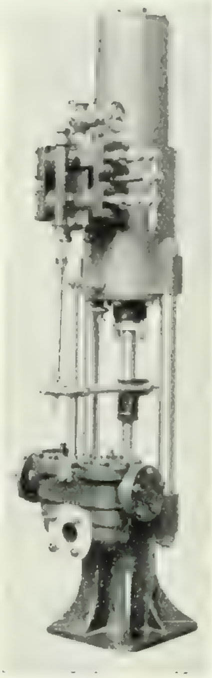


GRINDING, and . . . . .
POLISHING
MACHINES.
EMERY. . .
WHEELS. .
Etc. . . . . .

Send for our Enlarged Catalogue, free on Application.

J. P. HALL & SONS, Ltd.,

ENGINEERS,
PETERBOROUGH



We make a SPECIAL Compound Direct Acting Slow Running

Boiler Feed Pump

ECONOMICAL AND EFFICIENT.

We deliver 100 lbs. of Water for the expenditure of 1 lb. of Steam. This with our 2,000 gallon Pump, and a much higher efficiency as the size of the Pump increases.

AN IDEAL PUMP FOR GENERAL BOILER FEEDING PURPOSES.

APPLY FOR PARTICULARS

LOBNITZ' GOLD DREDGERS ARE AT WORK IN BRITISH NORTH AND SOUTH AMERICA, AFRICA, ASIA, &c.

LOBNITZ & CO., LIMITED,
Manufacture Dredge Plant. Most Improved Designs.

GOLD DREDGERS.

All parts made to gauge. Quick delivery of standard sizes.

Address Letters—
LOBNITZ & CO., LTD., RENFREW, SCOTLAND.

Telegraphic Address:
LOBNITZ, RENFREW. A1 Code used

The "Kingston" Patent Dredger & Excavator.

"Kingston" Dredger and Grab

Fixed upon a Hopper Barge of 150 tons capacity, having separate propelling engines and special boiler, as supplied to the Spanish Government

Sole Manufacturers and Patentees

ROSE, DOWNS & THOMPSON, Ltd., Old Foundry, HULL, and . . .
. . . 12, Mark Lane, LONDON.

THE "WELLS LIGHT" (Wallwork and Wells' Patents).

POWERFUL PORTABLE LIGHT FROM OIL
Up to 5,000 Candle Power.

For ENGINEERS, CONTRACTORS, SHIPYARDS, RAILWAYS, COLLIERIES, QUARRIES, MINES, HARBOURS, DOCKS, etc.

OVER 17,000 SOLD.

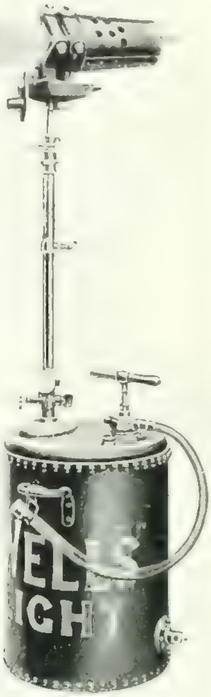
Supplied to 500 British and Foreign Railways.
Adopted by 26 Governments and all leading Firms
Exclusively used by the Great Military and Naval Powers.

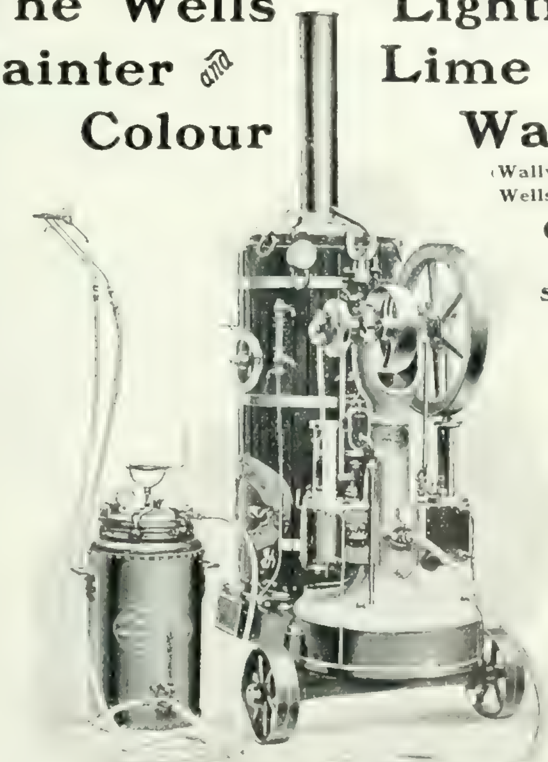
No. 0. Lamp. 500 Candle-power. Small Hand pattern ..	£7 7s.
„ 1. Do. [illegible] Candle-power. [illegible] pattern	£10 0s.
„ 2. [illegible] Candles. [illegible] pattern	£15 10s.
„ 3. [illegible] Candles. [illegible] pattern	£16 10s.
„ 4. [illegible] Candles. [illegible] Lamp	£17 15s.

[illegible]

The Wells 'Lightning' Painter and Lime and Colour Washer
(Wallwork and Wells' Patents).

Over 500 Plants supplied.





For Engineers, Contractors, Shipbuilders, Bridge & Girder Works, Boiler Shops, Wagon Works, Gas Works, etc., etc.

Adopted by 12 Governments and the Principal Railways and Gas Works in Great Britain.

THE Lightning Painter is operated by Compressed Air. [illegible] 25s. [illegible] Painters.

No. 1 Painter	£25 0s.
[illegible]	£30 0s.
[illegible]	£35 0s.
Single Air Compressor	£17 10s.
Double	£27 0s.
Vertical Engine Boiler and Air Compressor combined Boiler Lagged	£104 0s.

SILVER MEDALS AWARDED
PARIS EXHIBITION, 1900.

A. C. WELLS & Co., 100a, Midland Road, St. Pancras, LONDON, N.W.
Works: Cheetham, Manchester.

. THE NEW .

Calyx Patent CORE Drill.

CORES. 3 in. to 20 in. DIAMETER.

Petroleum and Artesian Wells.
True, Straight, and Permanent.
Applied successfully by

[illegible] of actual size

Leading Colonial Governments.
Perfect **CORES** guaranteed by
Special Patent Appliances.

Contracts undertaken for Boring

ARTESIAN WELLS & COALFIELDS.

COAL CORES A SPECIALITY.

The New Calyx Drill & Boring Co., Ltd.,
161 to 164, Dashwood House,
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FRIED. KRUPP GRUSONWERK

Magdeburg-Buckau (Germany).

Complete Plant
for
Linoleum Factories
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Machinery for the Manufacture of

LEAD CABLES.

Agent for Great Britain and Ireland.

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431 WILFLEY TABLES

Have been installed by the. . .
ANACONDA COPPER COMPANY,
and are now in use at that mine.

If you are in the market for CONCENTRATING MACHINERY, send for particulars of the No. 4 WILFLEY TABLE, to be obtained of the Sole Proprietors:—

THE WILFLEY ORE CONCENTRATOR SYNDICATE, Ltd.,
7-11, Moorgate Street, London, E.C.

[illegible]
[illegible]
[illegible]
GENERAL.

More than 4,000 Wilfleys have been sold.

Upwards of 600 mines are using our Concentrator.

STEEL & MALLEABLE IRON CASTINGS FOR ENGINEERS & TOOL MAKERS.
TO MACHINE CLEAN & BRIGHT ALL OVER.
PARKER FOUNDRY CO, DERBY.
ON ADMIRALTY LIST.

RAILS

FISHPLATES, BOLTS, SPIKES, CHAIRS &c.

POINTS AND CROSSINGS.

WILLIAM FIRTH LTD LEEDS

Ernest Scott & Mountain, Ltd.,
Electrical & General Engineers,
NEWCASTLE ON TYNE.
(ENGLAND.)

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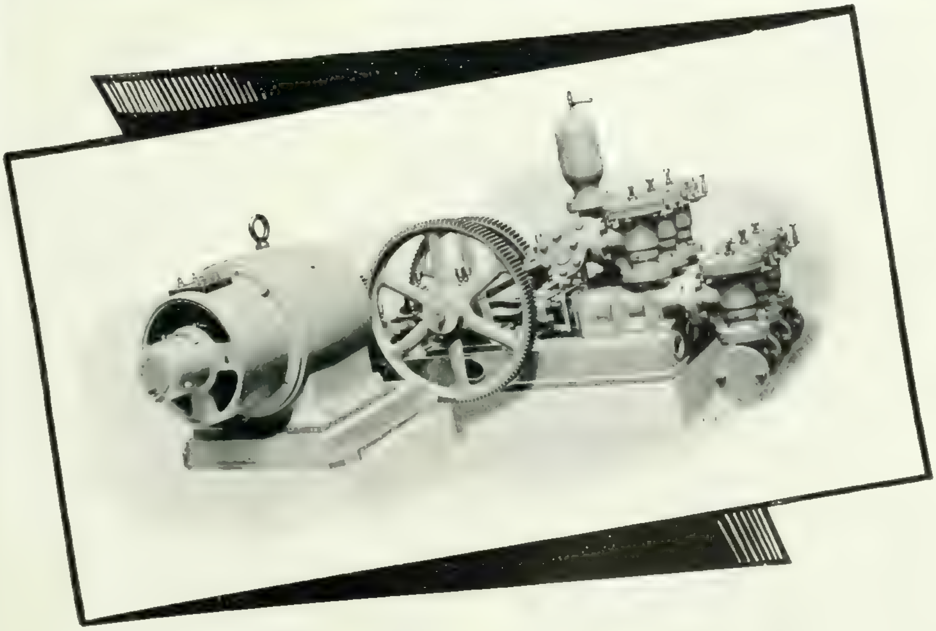
Branch Offices: London, Glasgow, Cardiff, Sheffield, Birmingham, Calcutta, Bombay, Bangkok, Shanghai, Johannesburg.



The . . .
Illustration.
shows one
of our Three
Throw . .
Mining . . .
Pumps and
Motors . . .
[illegible]

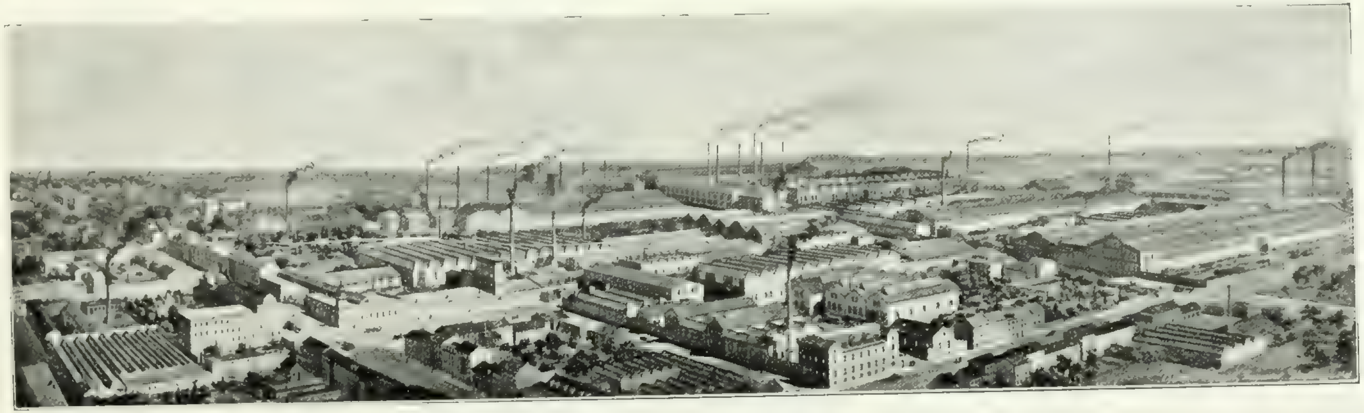
MINING MACHINERY

Pumps, Haulage Gears, Coal Cutters, Drills. Engines, Dynamos, Motors, Fans, Cranes, &c., &c.

THE

HUMBOLT ENGINEERING WORKS Co.,

KALK, near COLOGNE, GERMANY.



VIEW OF THE HUMBOLT WORKS, 1900. FOUNDED IN 1856.

MAKERS OF **MINING, ORE DRESSING, AND COAL WASHING MACHINERY,**

BROWN COAL BRIQUETTE MAKING PLANT.
LOCOMOTIVES, AND STATIONARY BOILERS,
Of Special Construction for burning Brown Coal.

Completely equipped Testing Works at Kalk, for testing bulk samples of Coal and Ore (3-10 tons) before tendering Plants.

Steam Engines, Pumps, & Fans of all kinds.
Reducing Machinery & Complete Plants.
Cement Making Plant.
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Magnetic Separating Plant (Wetherill system).
Perforated Plates, Coffered Plates.

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W. EDWARD KOCHS & CO., Engineers, High Street, Sheffield.

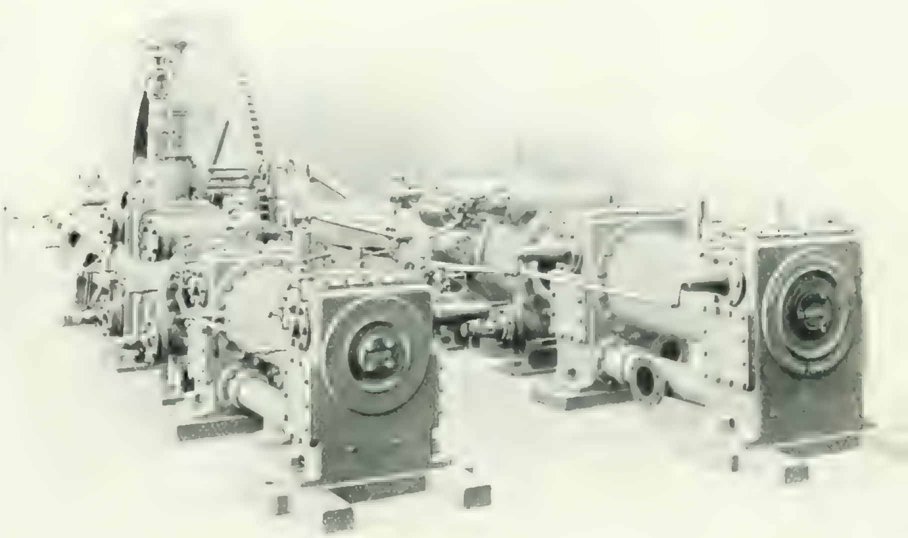
Fraser & Chalmers,

LIMITED.

ENGINEERING,
MINING,
MILLING,
SMELTING,
CONCENTRATION,
AND
LEACHING
MACHINERY

WINDING ENGINES.

Riedler Pumps.
Riedler Compressors.
Riedler Electric Pumps.



RIEDLER AIR COMPRESSOR.

Compound Air and Steam 423 [illegible]

FRASER & CHALMERS, LIMITED.

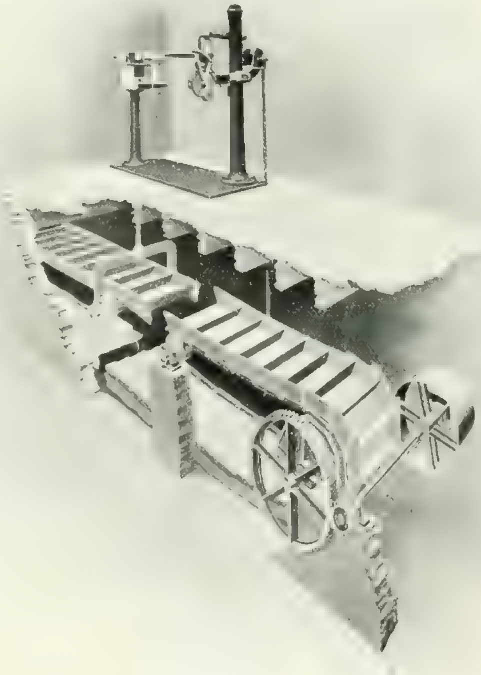
Offices: 43, THREADNEEDLE STREET, LONDON, E.C.

WORKS ERITH, KENT

BLAKE-DENISON

CONTINUOUS WEIGHER

(Patent).



Advantages.

The coal is not broken.

It is weighed while travelling.

Machine requires no attention.

It shows the aggregate amount of material passed over the conveyor in any given time.

THE ONLY CONVEYOR WEIGHING MACHINE ON THE MARKET.

Telegrams: "Weigh, Leeds."
Telephone No.: 1238.

FOR . .

COAL,
COKE,
AND
ORES
OF EVERY DESCRIPTION.

Send for Complete Description and List of other Automatic Weighing Machines to—

SAML. DENISON & SON,
MOOR FOUNDRY,
LEEDS.

Can be seen working at above address.

AËRIAL ROPEWAYS

AND INCLINES ON ALL SYSTEMS

CONSTRUCTED BY

BULLIVANT & CO., LTD.

(From designs by W. T. H. CARRINGTON, M.Inst.C.E.)

EXAMPLES AT WORK ALL OVER THE WORLD.

Ropeways constructed to carry from 50 to 2,000 tons per day. Suitable for the transport of all descriptions of materials.

ILLUSTRATED PAMPHLET MAY BE HAD ON APPLICATION.

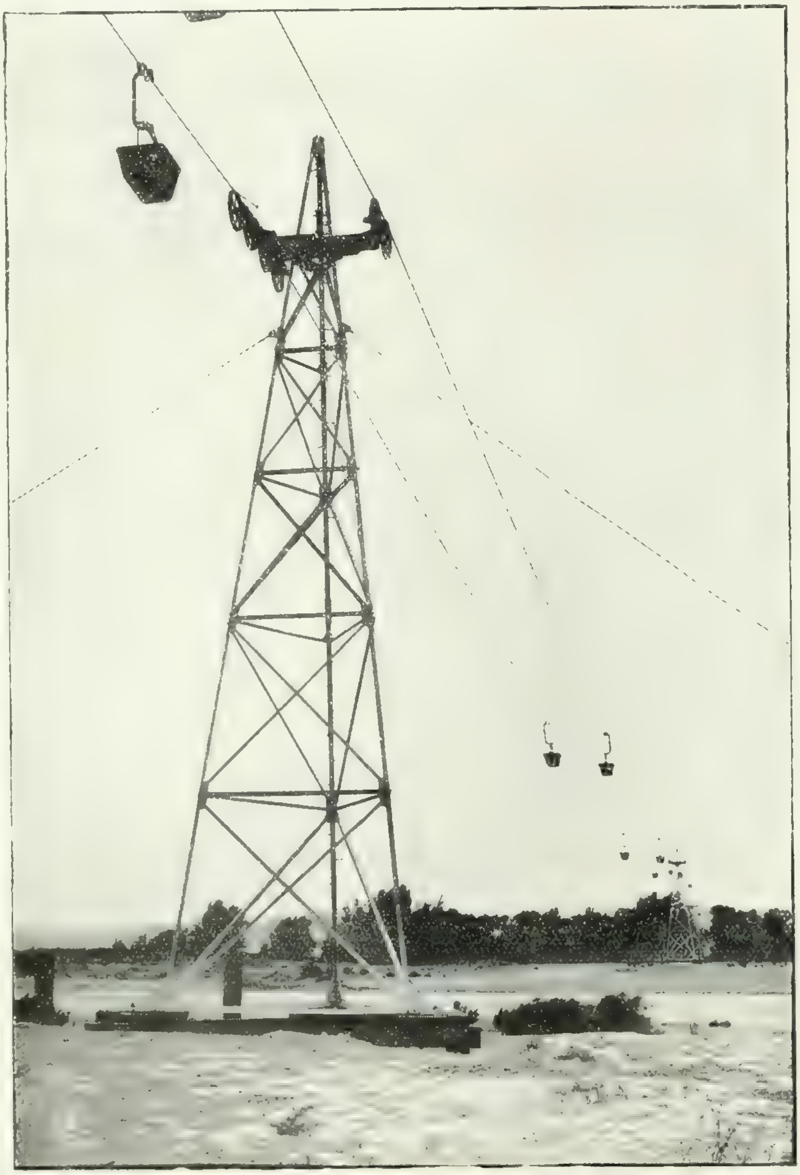
MAKERS OF

Flexible Steel Wire Ropes for Cranes, Lifts, Hoists, Suspension Bridges, Ropeways, &c., Hauling and Winding Gear, and Pulleys, Clamps, &c.

Regd. Office: 72, Mark Lane, E.C. Works: Millwall, E.

LONDON.

CHEAP TRANSPORT



PHOTOGRAPH OF A LINE CARRYING 350 TONS PER DAY

Improved Aerial Wire Ropeways

(Roe & Bedlington Patents)

The **Best** and **Cheapest** System for **Carrying Ores, Coals, Limestone, Bricks, Clay**, and other Materials, **Especially over Rough Ground,** and for any distance. **Capacity,** from 20 to 500 tons per day and over

Advantages

Over Other Systems.

Economy in Cost and Working.
Few Supports.
Reduced Wear of Cables.
Simplicity of Construction.
Long Spans and Steep Gradients Overcome.
High-Class Material.

NUMEROUS INSTALLATIONS AT WORK in England and Abroad, GIVING THE GREATEST SATISFACTION. Inquirers should state LENGTH, CAPACITY, and NATURE OF GROUND.

Estimates, Pamphlets, and full Particulars on application to

The ROPEWAYS SYNDICATE, Ltd., 30, ST. MARY AXE, E.C.

Telegraphic Address: "ROPEWAYS, LONDON."

Estimates Cheerfully Furnished

ADOLF BLEICHERT & Co., LEIPZIG-GOHLIS,
GERMANY

Oldest and Largest Manufactory for the construction of

BLEICHERT'S

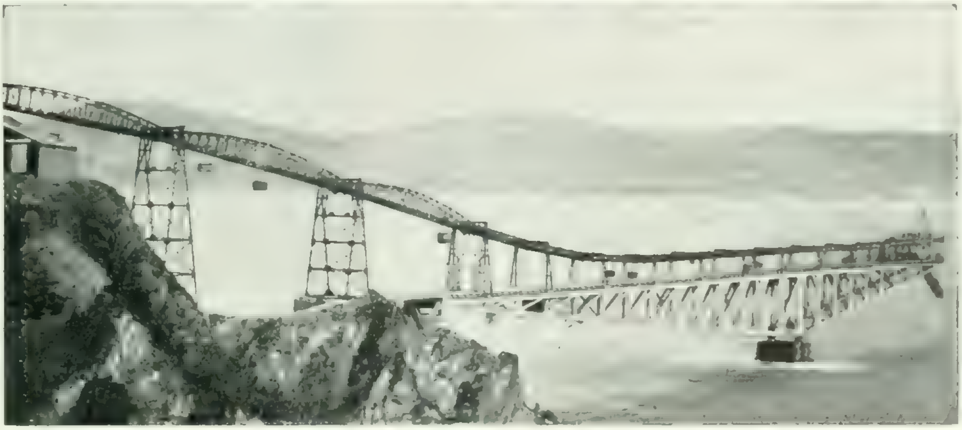
WIRE ROPEWAYS.

[illegible] 1,500 [illegible]
[illegible] 30 [illegible]

AN EXPERIENCE of 30 YEARS.

Gold Medals. Highest Awards

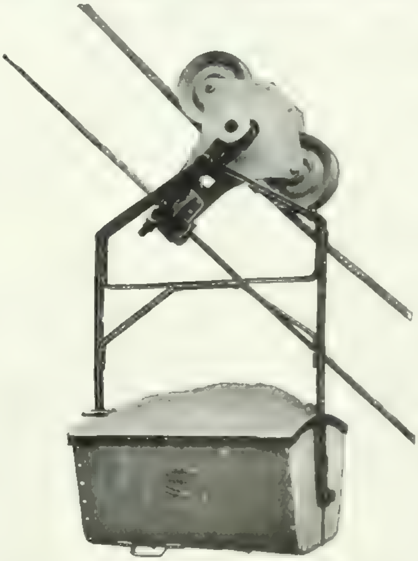
PLANT ERECTED FOR THE VIVERO IRON ORE CO., VIVERO, SPAIN.



Loading Pier in connection with the Wire Ropeway of a length of 5,500 m., for the discharging of ore direct into ocean steamers.

LATEST INVENTION.

Patent Jaw-Grip Coupling-Apparatus, "Automat."



Working absolutely self-acting and with unfailing security.

Overcomes all difficulties of the ground under the most adverse circumstances.

Steep gradients of 1·1 are easily taken.

Special Department for the construction of
CABLE-HOIST CONVEYORS, LOADING and UNLOADING MACHINERY, CRANES, &c.,
as per advertisement of the preceding and following [illegible]

Representative
J. SCOTT-ANDERSON, M.I.Mech.Engrs., M.I.Electr.Engrs.
SHEFFIELD, Royal Insurance Buildings.

Estimates Cheerfully Furnished.

MANUFACTURERS OF

Weldless Steel

and . . .

Iron Tubes,

Steam Pipes, Hydraulic Tubes, Boiler Tubes, High Pressure . . Steam Mains,

HOLLOW FORGINGS,
COLLARS, FERRULES,
BUSHES, LINERS,
COUPLINGS, AXLES,
PISTON RODS,
Etc., Etc.,
Quoted for on . . receipt of . . . particulars.

Tubes

FOR

Super-heaters

A SPECIALITY.

Contractors to the War Office and Admiralty.

TUBES LIMITED,

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Nat. Telephone No.: 2582. Telegrams: "Cylinders, Birmingham."

THOMAS PIGGOTT & Co., LTD., ATLAS WORKS, SPRING HILL, BIRMINGHAM.

GAS, HYDRAULIC and GENERAL ENGINEERS

* * *

Gas Plants and Constructional Ironwork of all descriptions.
Columns Girders, Castings.
Welded and Rivetted Steel Pipes.
Stamped and Steel Angle Flanges.
Steel Chimneys of all sizes and designs.
Tanks in Steel or Cast Iron for Petroleum & Water.
Pans for Sugar, Cassada, &c., for all Markets.

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London Office.
14, Gt. St. THOMAS APOSTLE

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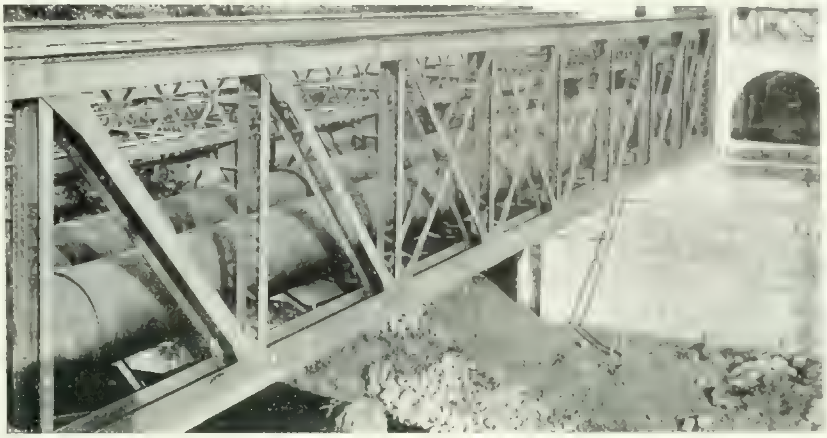
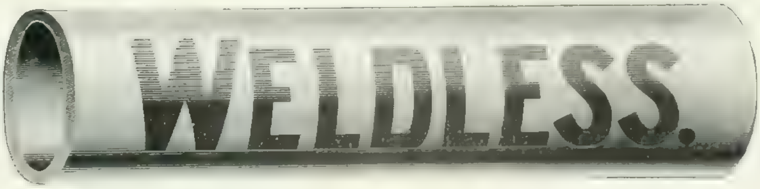


Steel Lattice Girder Bridge [illegible] over the River [illegible] carrying Welded Steel Main [illegible] Birmingham [illegible] Water Scheme.

THE WELDLESS STEEL TUBE Co., LIMITED,
ICKNIELD PORT ROAD, BIRMINGHAM.

WELDLESS.
TRADE MARK.



The Original Makers of
PATENT WELDLESS STEEL TUBES

ON ADMIRALTY LIST.

ESTABLISHED 1872.

For BOILERS
HYDRAULIC PRESSES
FERRULES
BORING RODS
BUSHES
SHAFTING
COUPLINGS &
GENERAL ENGINEERING PURPOSES

HAMMERING BLOOMS.

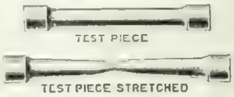
Farnley Iron.

This "Best Yorkshire" iron, so well known for the last fifty years as specially tough and ductile, is made from Cold-blast Pig Iron, remelted and refined before puddling.

Farnley Bar Iron is used in **Mining** for pit cages, suspending gear, and other important parts, and on all the leading **Railways** in Great Britain, India, and the Colonies, for shackles and other vital parts subjected to repeated shocks. Farnley Iron will stretch cold from **$1\frac{1}{8}$**-in. to **$2\frac{1}{8}$**-in. in a length of **6**-in. before fracture, and is safest for **welding.**

Farnley Iron costs **double the price** of ordinary iron, that is about **2***d.* per lb. as against **1***d.* per lb., and this value is the measure of quality in the estimation of buyers. When a forging costs from **9***d.* to **20***d.* per lb., the extra **1***d.* is not prohibitive when it ensures certainty in welding and a forging of double value. In short, the **Best Iron is the Cheapest.**

Address: The Farnley Iron Co., Ltd., Leeds, England.

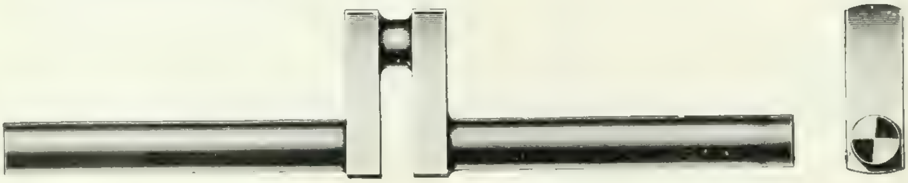


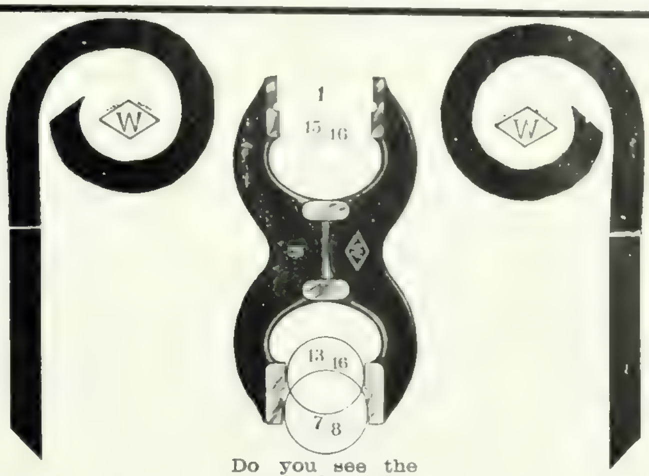
ON ADMIRALTY LIST.

Telegrams: "CRANKS, LINCOLN."

FOR CRANKS & FORGINGS OF EVERY DESCRIPTION WRITE TO

CLARKE'S CRANK & FORGE CO., LTD., LINCOLN, ENGLAND.





Do you see the length of measuring pad? By design one forging (furnished unfinished only) provides for five classes of gauges. Unusual Sizes. ¼ to 4 ready. Circular No. 858 & sample gauge free.

J. H. WILLIAMS & CO.,
Drop forgings only.
BROOKLYN, NEW YORK.

Brown Bayley's Steel Works, L^TD.

SHEFFIELD.

Telegraphic Addresses { "BAYLEY, SHEFFIELD."
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Manufacturers of Steel by the "SIEMEN'S" and "BESSEMER" Processes.

MAKERS OF . .

Tyres, Axles, and Springs for Railway Locomotives, Railway Carriages and Wagons, and for Tramway Engines and Cars.

Special Guaranteed Spring Steel for Railway Locomotive Springs, Railway Carriage and Wagon Springs, and for Lorry, Dray, and Cart Springs.

STEEL FORGINGS.

Planished Steel Bars for Shafting for Engineers, and Agricultural Implement Makers.

SPECIAL STEEL BLOOMS AND SLABS.

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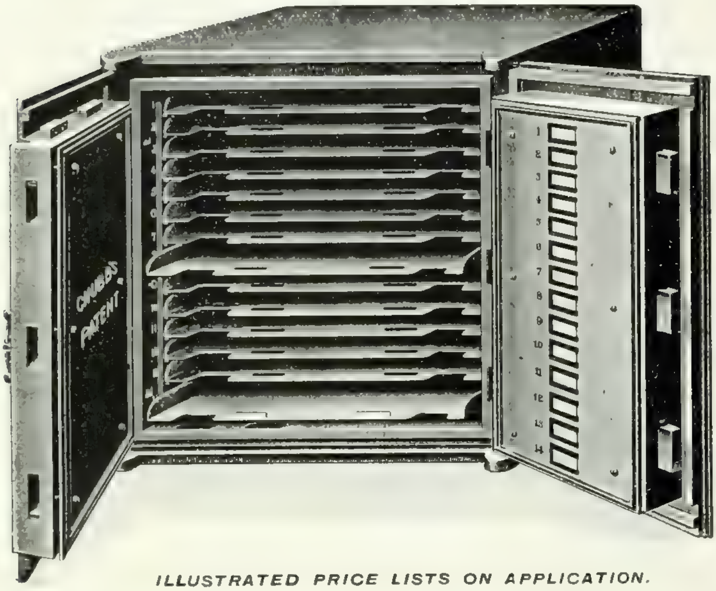

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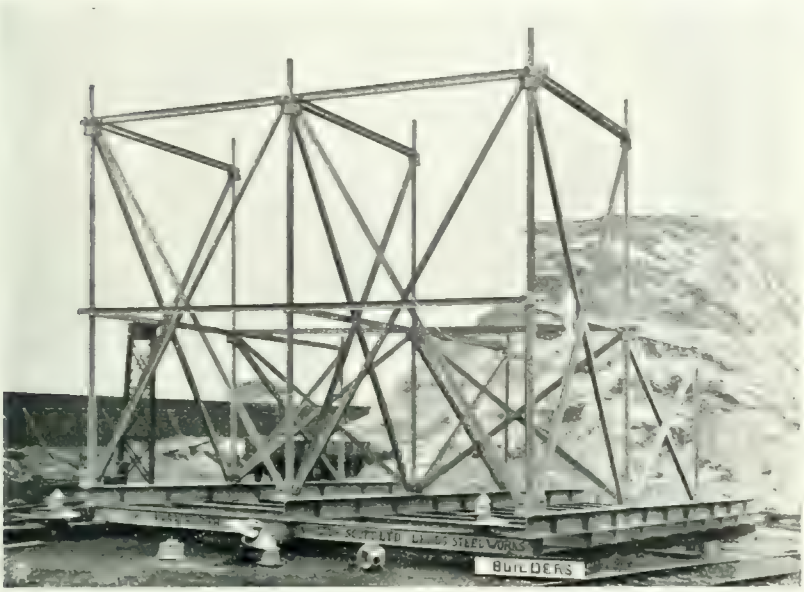

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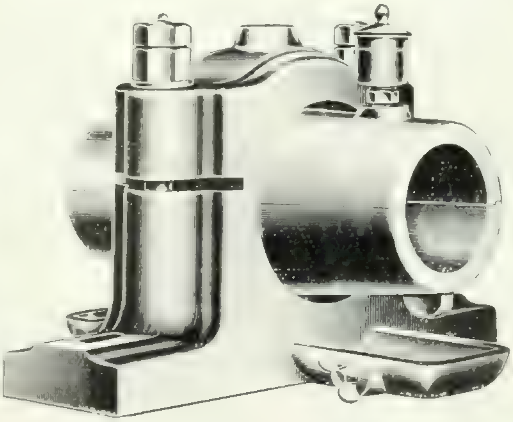

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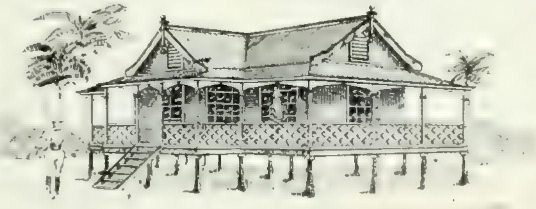

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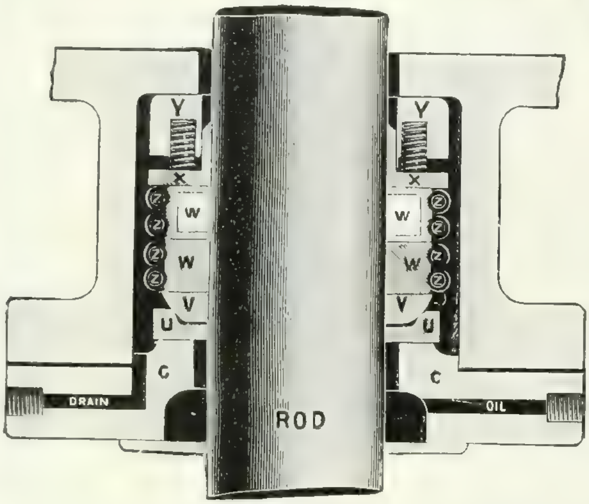

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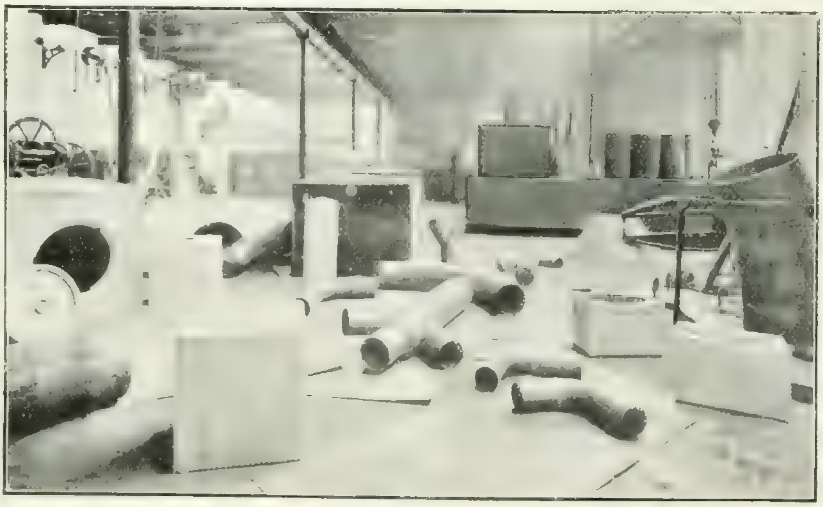

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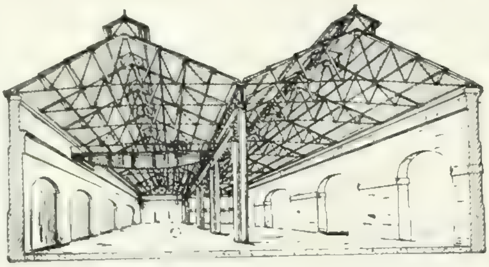

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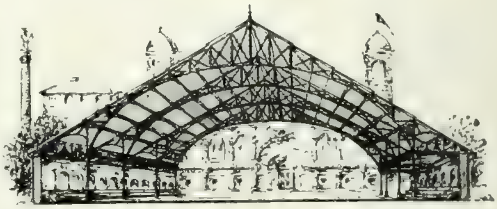

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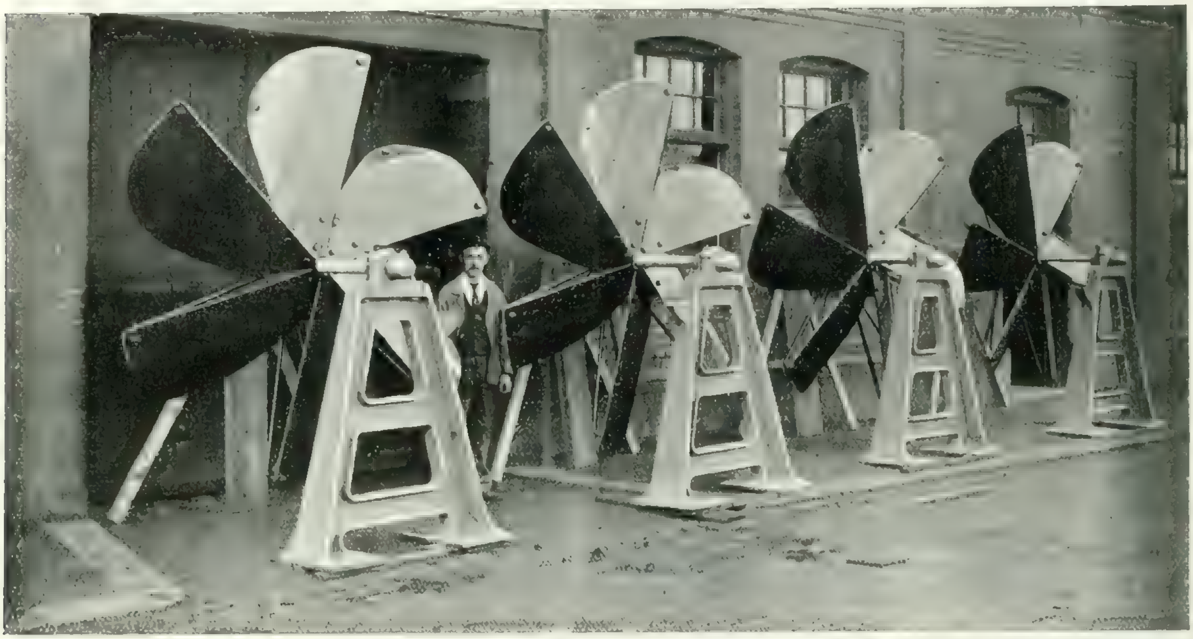

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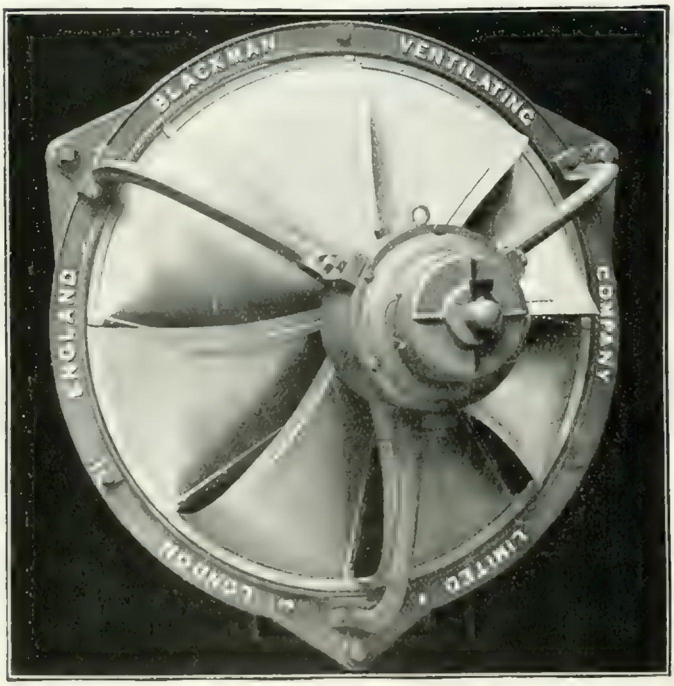

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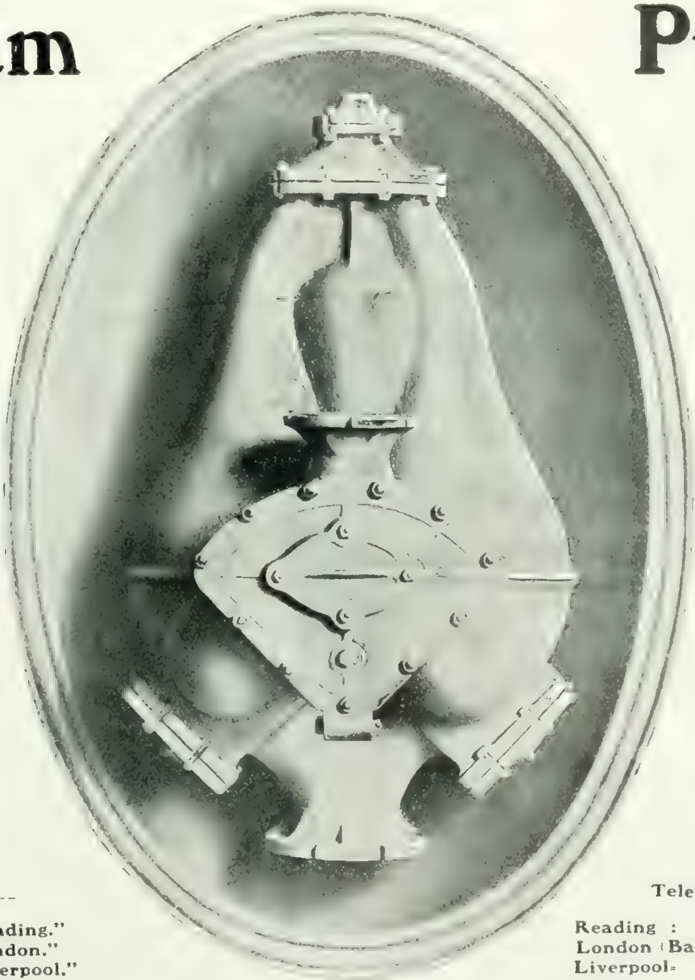

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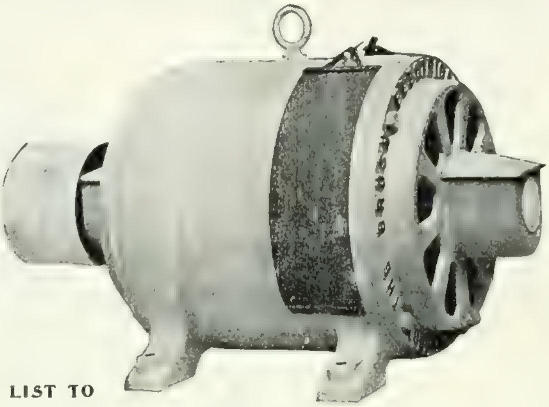

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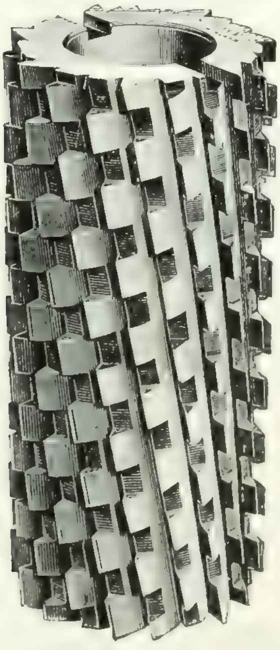

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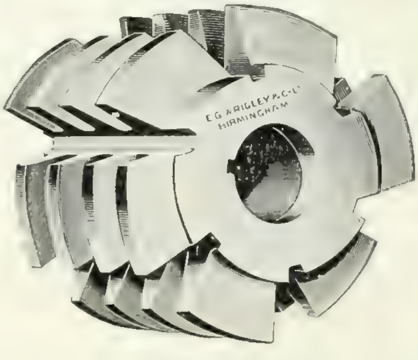

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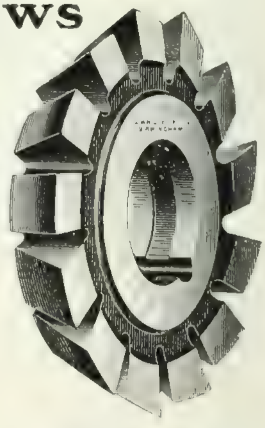

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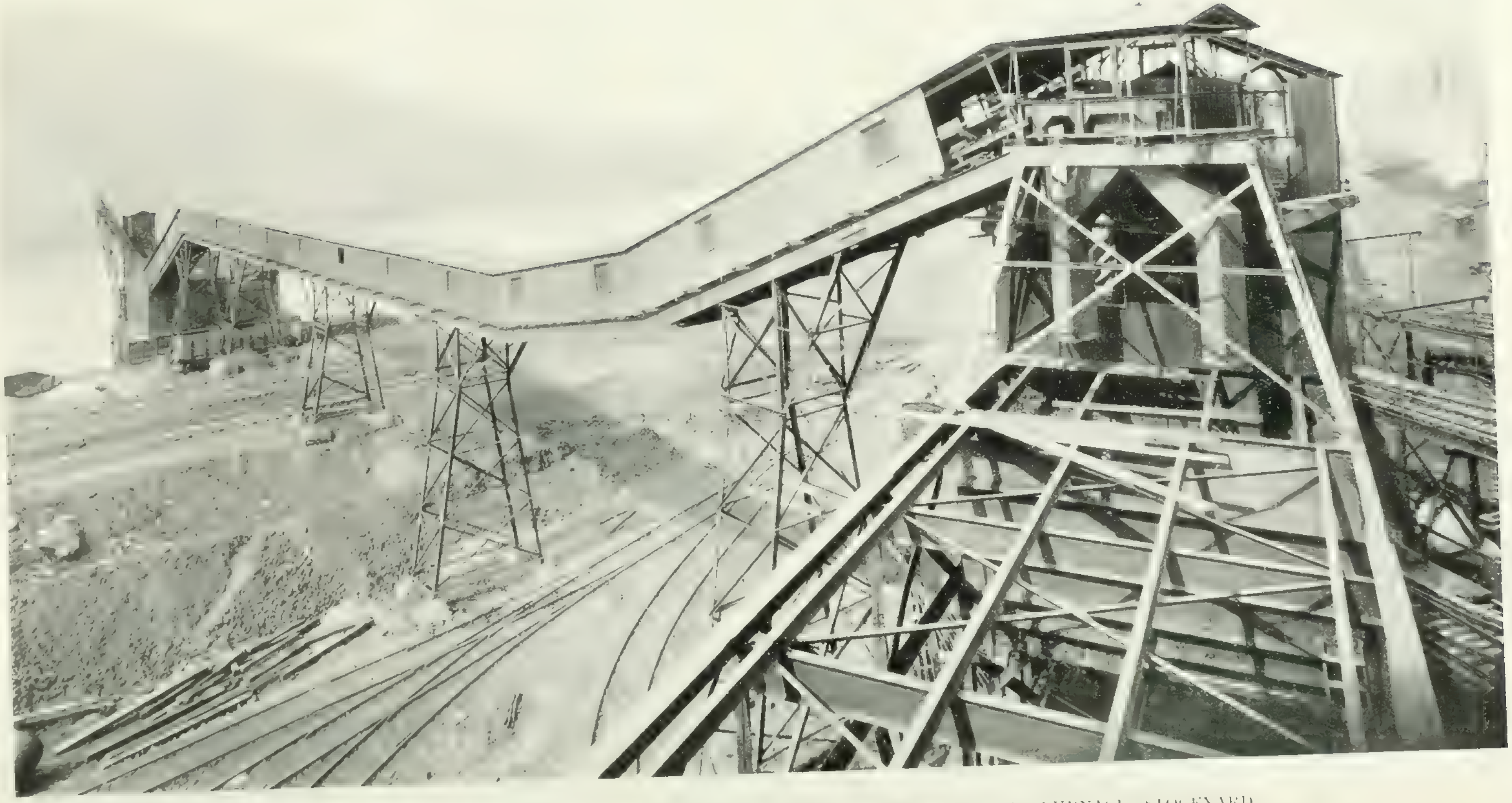

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BY

N. I. D.

It is generally assumed that at this time of the year the Naval Estimates are in course of preparation by those officials who are not enjoying their holidays; and for several reasons special interest attaches to the Estimates to be presented to Parliament next year. In the first place, if general expectation be fulfilled, these Estimates should exhibit some mark of the mind of the new Director of Naval Construction. This in itself would direct particular attention to the votes which cover shipbuilding and design, but in addition there are questions connected with the struggle for supremacy between guns and armour, with the relative value of speed, and with the most efficient and economical method of generating steam, which cannot fail to give these matters additional importance. It is in taking into consideration the trend and bearing of each change in its relation to these questions that the difference lies between the professional aspect and the point of view of the public. It is, perhaps, only natural that what we may term the casual observer of naval affairs should be inclined, on learning that a new ship is to be built, to limit his regard to the more prominent characteristics, and to base his estimate of improvement or otherwise upon a comparison of these with the similar characteristics of other vessels of the same or like classes. The result of such casual and misleading comparisons must be familiar to all students of naval affairs who watch the daily and weekly press and the magazines intended for general reading. The outgrowth takes the shape commonly of articles in which, for instance, displacement alone is sometimes regarded as the essential factor for purposes of comparison between rival ships or rival fleets, sometimes gun power, and sometimes speed. It is, indeed, true that each of these attributes and others, such as coal endurance, may in turn become the chief factor of immediate efficiency, but a more intelligent appreciation will be formed by taking into account all the elements which contribute to the effectiveness of a ship of war, in relation to the duties required of the vessel. It may be as well then to summarise here the several qualities which in a greater or less degree are combined to make up what has been called battle-worthiness.

QUALITIES DESIRABLE IN SHIPS OF WAR.

It will be readily understood that the importance of each of these qualities varies relatively to the duties which each ship may be called upon to perform, and that in our enumeration of them they are not placed in order of value as regards any particular class. *Displacement* is primarily a measure of the vessel's power to carry a certain weight, which weight may be distributed in various ways. It is possible to imagine two ships of precisely the same displacement, yet of entirely unequal value so far as battle-worthiness is concerned. The fleets of all the Powers may be made to yield examples demonstrating the misleading nature of comparison by displacement alone. *Offensive power* is a quality which may be given by guns, torpedoes or other weapons, or by several kinds together, and may be affected in a marked degree by the distribution of these weapons. The method of placing the guns in a ship may, and generally does, have an important bearing on her tactical use. *Defensive power* depends mainly on the resisting value of armour to projectiles and its extent and distribution in relation to the vulnerable and vital parts of the ship. *Locomotive power* includes speed, coal endurance, the economy and efficiency of the boilers and machinery, with the very important quality of being able to proceed rapidly from a position of rest to one of action; in other words, to raise steam with the least possible delay. *Handiness* involves satisfactory steering power, obedience to the helm, and steadiness in relation to the course, which is not to be found to the same extent in all vessels. As is now well known, every ship may be said to have her own idiosyncrasies in this connection, and until these have been discovered, the handiness of the ship cannot be developed to its fullest extent. *Sea-worthiness*, in itself a combination of elements, is, it goes without saying, essential to every ship. In a war vessel it includes, amongst other things, steadiness as a gun platform, and habitability for the crew in a reasonable measure. Last, but not least, there is "*the man behind the gun*," a comprehensive term, which may be said to include efficiency in numbers, in discipline, and in training, of the vessel's officers and men. As has been very truly said, it will be of very little account in the day of battle for the ship to have been well designed, for her engineers to have brought her to the place of action, and for her guns to be of the very latest model, if it be then found that her men cannot shoot straight and hit the enemy.

At another time we may consider the relative importance of the various elements we have described in those various classes of vessels whose duties differ as widely as do those of a battleship and a torpedo-boat. One word, however, may be said on the need for homogeneity in regard to the proportion of each element in each class of vessel. It should be obvious that it is useless in a group of vessels intended to manœuvre and fight together to make large differences in their respective powers, whether for offence, defence, locomotion or handiness. Any such differences must result in waste of power, and waste is abhorrent.

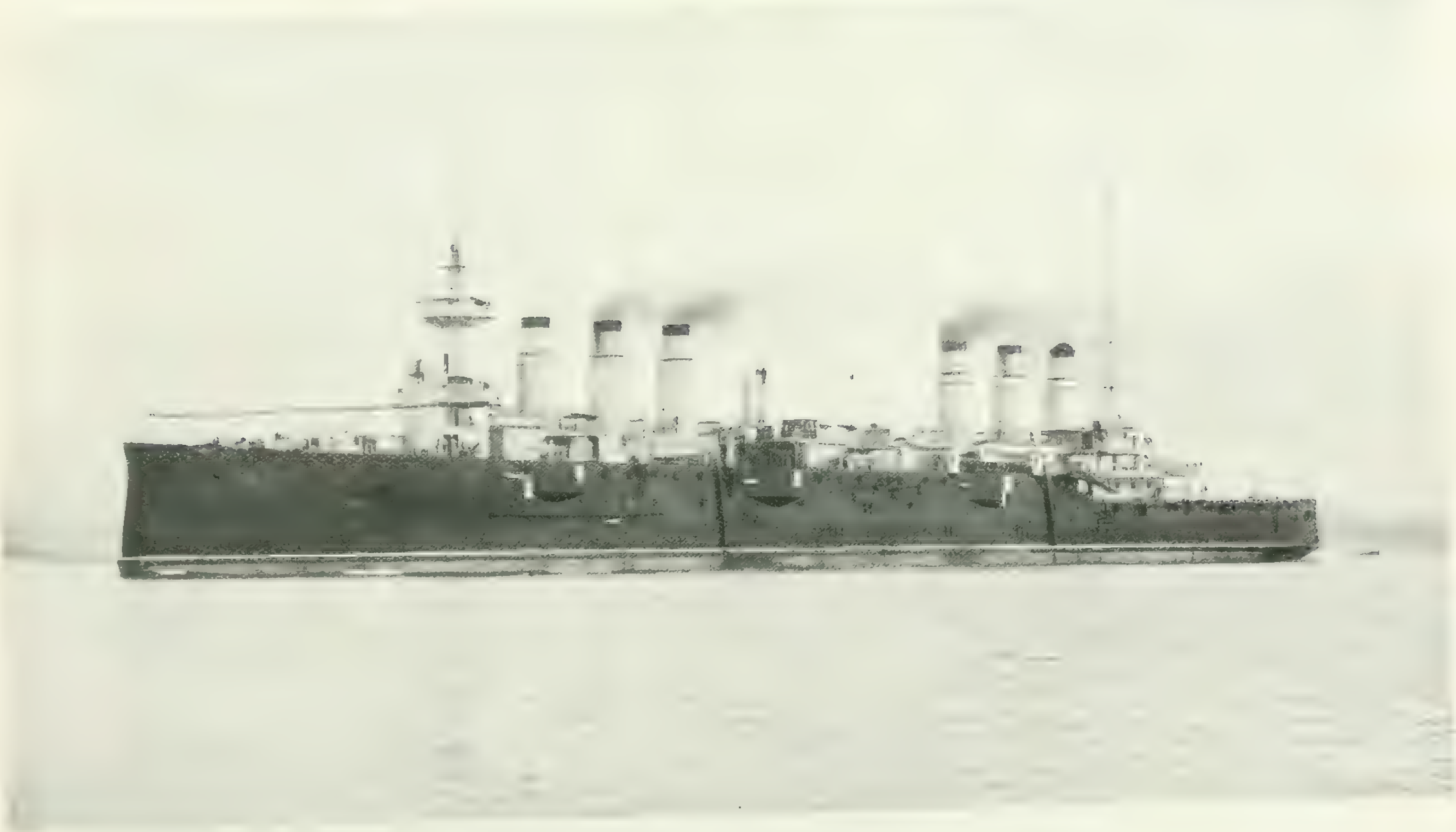
GREAT BRITAIN.

The two most important vessels in the programme of 1900-1901 were the battleships *Queen* and *Prince of Wales*. These vessels have not previously been described in these Notes, and, as they present some novel features, the following characteristics will be useful for purposes of comparison: The displacement is 15,000 tons, which is also that of the *Formidable* class. The length is 400 ft., breadth 75 ft., and mean load draught 26 ft. 9 in. The armoured protection, which is also similar to that in the *Formidable*, consists of a 9 in. belt, commencing from the after barbette and running forward to within 30 ft. of the bow, where it is continued right forward with a thickness of 2 in. of armour. At its after end there is a curved transverse bulkhead of 12 in., armour protection being continued to the stern by a deck 2 in. on the slope and 1 in. on the flat, which extends the entire length of the vessel. The belt itself is 15 ft. deep, and there is no bulkhead forward. The barbettes carrying the principal guns, two 12 in. 50-ton wire-bound breech-loaders in each, are protected by armour varying in thickness from 6 in. to 12 in., the hoods of the barbettes varying also in thickness from 8 in. to 10 in. The secondary armament of these vessels differs from that in the *Formidable* class; the former being provided with eight 7·5 in. quick-firing and ten 6 in. guns, the casemates for these pieces having 6 in. plates. As designed, these are the last British battleships to carry their secondary armaments in casemates. The machinery is practically identical for the two ships, and will consist of two sets of the inverted three-cylinder triple-expansion type, arranged to work twin

(*Continued on page* [illegible].)

FRENCH CRUISER "JEANNE D'ARC."

Displacement 11,27[illegible] tons. Heaviest Gun, 7 [illegible] [illegible] Armour, [illegible] I.H.P. [illegible] Nominal Speed [illegible]



THE FRENCH CRUISER "JEANNE D'ARC." ANOTHER VIEW.

Naval Notes.

[illegible]

screws of 17 ft. 6 in. in diameter. The cylinders are 31·5 in., 51·5 in., and 84 in. in diameter respectively, with a 4 ft. 3 in. stroke. The number of revolutions when developing 15,000 h.p. is calculated to be 108 per minute, and when developing the contract power of 20,000 h.p. is estimated to give a speed of 19 knots. Steam will be given in the *Prince of Wales* by twenty water-tube boilers of the Belleville type, placed in three compartments, but in the *Queen* the type of boiler chosen is that of Babcock and Wilcox.

Armoured cruisers of the "County" class, of which mention has already been made in previous issues, are now coming to the front, the *Bedford* being the most advanced, having already undergone some of her trials at Devonport. The other vessels of the class are the *Kent*, laid down at Portsmouth, February 12th, 1900, and launched March 6th, 1901. This vessel is now being pressed forward. The *Essex*, laid down at Pembroke January 1st, 1900, was launched August 29th, 1901, and should soon be ready for her trials. The *Monmouth*, building by the London and Glasgow Shipbuilding Company, was launched on November 13th, 1901; the *Lancaster*, building at Elswick, on March 22nd, 1902. The *Cornwall*, building at Pembroke, is to be ready for launching in October. The *Suffolk*, laid down at Portsmouth, March 25th, 1901; the *Berwick*, building by Messrs. Beardmore; the *Cumberland*, by the London and Glasgow Company; and the *Donegal*, by the Fairfield Company—ten in all. There are also six vessels of the "County" class ordered to be built, but with slightly different design. These are the *Devonshire*, building at Chatham, and the *Antrim*, *Argyll*, *Hampshire*, *Carnarvon*, and *Roxburgh*.

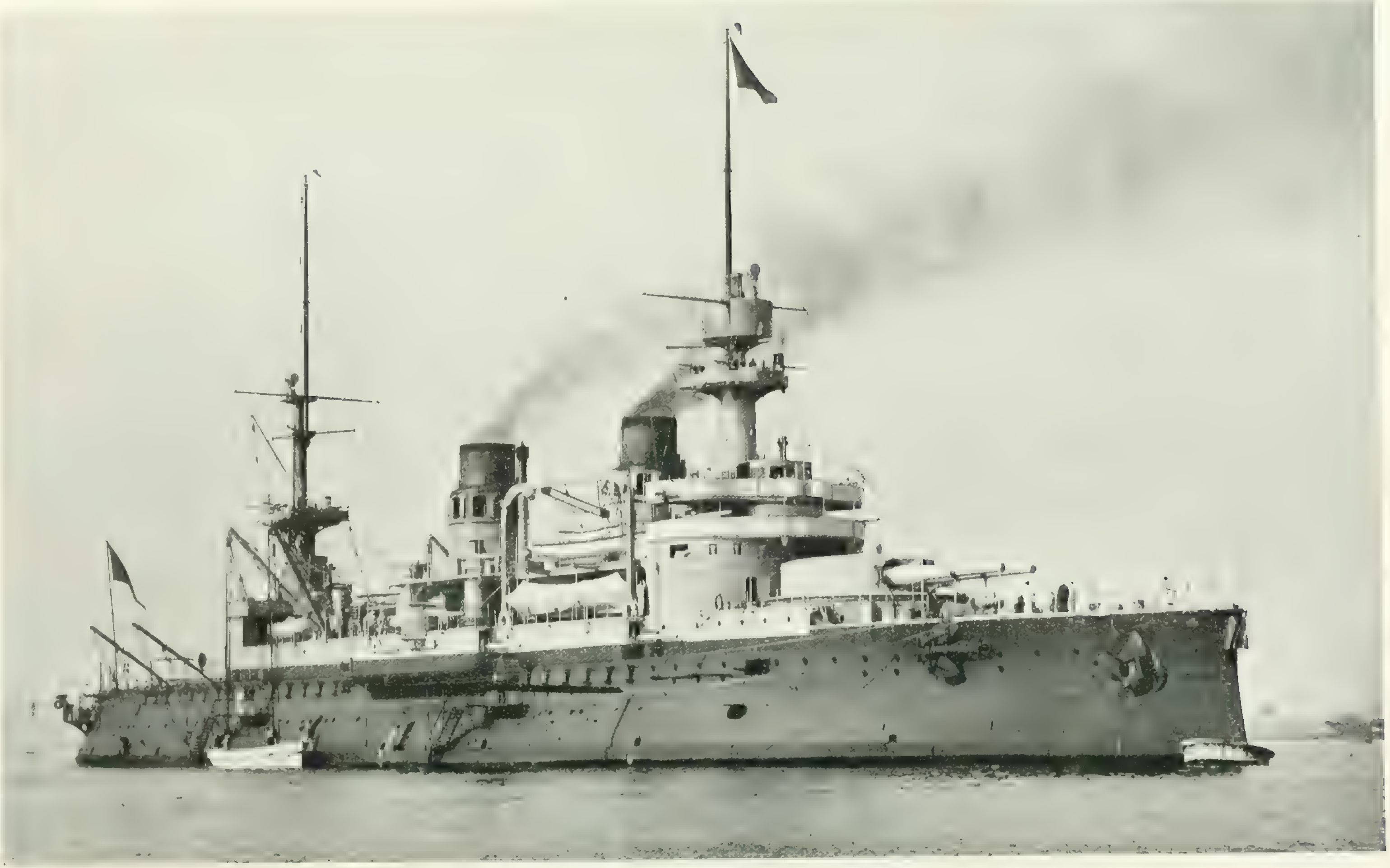
It will be remembered that in last year's programme reference was made to a new class of "scouts," and in connection with these vessels it was proposed to revert to the method used in the case of the torpedo-boat destroyers. The private shipbuilders of the country were asked to give the Admiralty the benefit of their creative ingenuity by submitting designs to fulfil certain stated conditions. These designs have now been received, and it is expected that before long the First Lord will make an announcement in regard to the distribution of the tenders for these vessels.

FRANCE.

Reference has already been made in these notes to the influence upon the progress of the French Navy of a change in the Ministry or of the Minister responsible for the Navy. M. Pelletan had hardly succeeded M. de Lanessen before indications were apparent that such a change was imminent. Of the six battleships authorised by Parliament, two were to be built, and the contracts had been signed with the Chantiers de la Gironde and the Chantiers de la Méditerranée for their construction. M. Pelletan has now notified the contractors that the financial state of the country does not encourage the hope that money will be available for these vessels. Whether he will be able to divert the amounts voted to other purposes has yet to be seen, but that delay in the completion of these vessels will result is fairly certain. In the meantime it is announced that the battleship *République* will be launched on September 4th, at Brest; and as by the previous arrangements the *Démocratie* was to take her place on the slips, we may then have an indication of how far M. Pelletan's ideas will prevail.

With the laying down of the two armoured cruisers, *Jules Michelet* and *Ernest Renan*, the naval programme of 1900 may be said to have been completed, so far as this class of vessel is concerned. The demand of the Superior Council was for three divisions of eight vessels each, but provision was only made for twenty-three. In these twenty-three cruisers there are eight different types, of which four were mentioned in the first issue of this magazine, the others being the *Dupuy de Lôme*, of 6,300 tons displacement; the *Amiral Charner*, of 4,700 tons; the *Pothuau*, of 5,300 tons; and the *Jeanne d'Arc*, of 11,200 tons displacement. The last-named were the heaviest vessels until the *Léon Gambetta* class was designed, and it is to this class that the *Michelet* and *Renan*, of 12,500 tons each, belong. These five vessels are estimated to cost £1,200,000 each.

On July 24th the *Gnôme* submarine was launched at Rochefort. This vessel is 135·8 ft.



FRENCH BATTLESHIP "SAINT LOUIS."

Displacement, 11,2[illegible] tons. Heaviest Gun, 12-in. Thickest Armour, 15¾ in. I.H.P. 14,000. Nominal Speed, 18 knots.

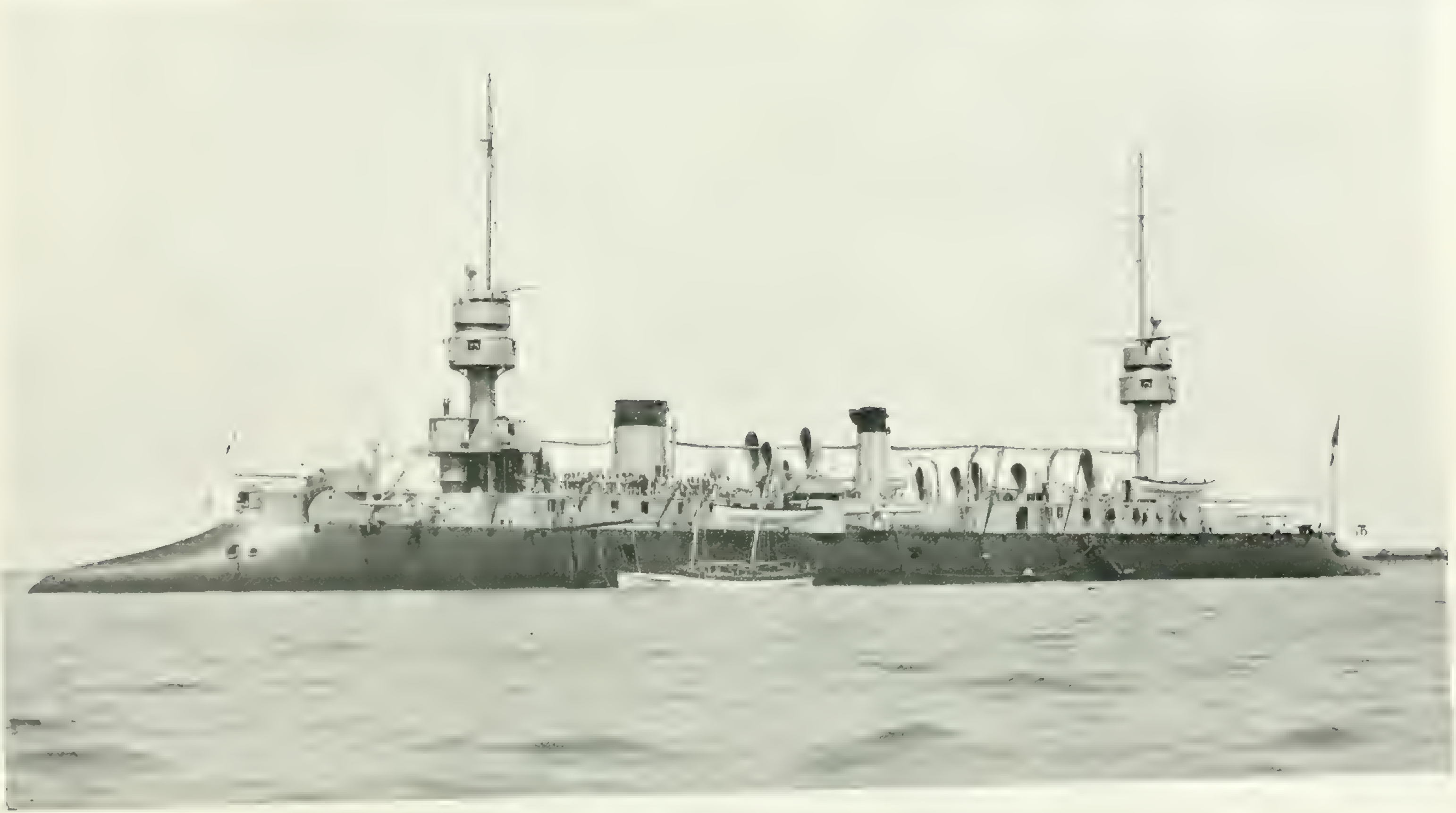
long, 9·5 beam, with a draught of 9·5 ft. Her displacement is 185 tons; she is expected to have 12·5 knots speed awash, and 9 knots when submerged. She is one of the largest class of submarines, her sister ships being the *Farfadet*, *Korrigan*, and *Lutin*.

GERMANY.

Last month we referred to the new type of German battleship, of which four are in hand. These are H., commenced at the Germania Yard, Kiel, on October 24th, 1901; J., which is in hand at Dantzig; K., which is to be built at the Vulcan Yard, Stettin; and L. at the Germania Yard. These are the largest battleships yet put in hand in Germany. The displacement is 13,200 tons, as compared with the 11,800 tons of the *Wittelsbach* class. The length is 398 ft. 6 in., the beam 72 ft. 10 in., and the draught 25 ft. 10 in., all of which dimensions show an increase upon those of the previous type of battleship. These vessels will have a complete belt of armour of 9 in., and 4 in. of Krupp steel with the armoured deck curved down to the lower edge of the belt for further protection. Above the side armour will be armour for the citadel, and above this again an armoured battery, in which will be mounted ten 6·7 in. quick-firers. Four similar guns will be mounted in the citadel in turrets at the four corners, while two barbettes at either end will mount two guns of 11 in. calibre each. These gun positions will be protected with 10 in. of Krupp steel, and the bases of both barbettes and turrets will be well protected. Of six torpedo tubes, five will be submerged. The boilers of these ships will comprise a proportion both of the cylindrical and water-tube types, and the engines are to be capable of developing 16,000 h.p., giving a speed of 19 knots. The normal coal capacity is 800 tons. Six torpedo-boat destroyers have been ordered of Schichau. These vessels, to be numbered 114 to 119, will be of 350 tons displacement, 6,000 h.p. and 28 knots speed.

RUSSIA.

Reference was made in the July issue to the battleship *Orel* of the new programme, building at Galerny Island. This vessel, begun on June 2nd, 1900, was launched on July 20th, when about 56 per cent. of the work on her had been completed. Her length will be 398 ft. 11 in., beam 76 ft., draught 26 ft., displacement 13,516 tons. The engines, of 15,800 h.p., will be supplied by twenty Belleville boilers and give a speed of 18 knots. The armament comprises four 12 in., twelve 6 in. quick-firing, twenty 2·9 in., and several smaller guns, besides four torpedo tubes, two of which are submerged. Some of her armour is to be supplied by the Carnegie Steel Company, and a recent trial was made of test plates in the United States. These plates were of 4 in., treated by the Krupp process. A 4 in. gun and a Wheeler Sterling projectile of 33 lbs. were used for the trial. Four rounds were fired, the last with a capped projectile. The striking velocity of the four rounds was respectively 1,837 ft. sec., 1,845 ft. sec., 1,830 ft. sec., and 1,834 ft. sec.; and the energy was 771 ft. tons, 778 ft. tons, 766 ft. tons, and 769 ft. tons. The last made a clean hole through the target. The battleship *Kniaz Potemkin Tavrichesky*, which was begun at Nikolaiev on December 7th, 1897, and launched on October 9th, 1900, has now been sent to Sebastopol to be completed. The length of this vessel is 378 ft. 6 in. over all, and at the water-line 371 ft. 2 in. Her beam, 73 ft; draught, 27 ft.; displacement, 12,600 tons. Steam is provided by Belleville boilers, one group heated by coal and the other by petroleum. Her coal capacity is 760 tons, and petroleum storage 580 tons. The engines, of 10,600 h.p., are to give her a speed of 16 knots. Her armoured belt extends 237 ft. amidships, having a thickness of 9 in., and is continued to the ends fore and aft with a thickness of 3 in. Over this is a strip 6 in. thick, extending for a distance of 156 ft. amidships, and above this again another strip 5 in. thick extending for a length of 168 ft. Bulkheads close in the batteries, the armour being respectively 7 in., 6 in., and 5 in. in thickness. Two armoured decks are provided, the maximum thickness on the sloping part of the lower one being a little less than 2 in. All the armour used is treated by the Krupp process and made in Russia. The armament consists of four 12 in., sixteen 6 in., fourteen 2·9 in., and some smaller guns, the larger calibres being of the Canet type.



FRENCH CRUISER "DUPUY-DE-LÔME."

Displacement [illegible] tons. Heaviest Gun 7·[illegible] in. Thickest Armour [illegible] in. I.H.P. [illegible]. Nominal Speed [illegible] knots.

Naval Notes.

[illegible]

THE GERMAN CRUISER "PRINCE HEINRICH."

[illegible]

On the same day that the *Orel* was launched, the Czar performed the ceremony of the *zakladka* on the new Russian cruiser *Oleg*. This vessel was begun on November 21st, 1901. Her length will be 433 ft. 10 in., beam 54 ft. 5·5 in., draught 20 ft. 7 in., and displacement 6,675 tons.

UNITED STATES.

The battleship programme of the United States contains many interesting features. It may be said to have begun with the *Kearsarge* and *Kentucky*, launched in 1898, and displacing 11,540 tons. In these vessels was introduced the system of superposed turrets, four 8 in. guns being coupled in two smaller turrets upon the top of the large turrets for four 13 in. guns. This system was not applied in the *Alabama*, *Illinois*, and *Wisconsin*, of 11,525 tons, nor again in the *Maine*, *Missouri*, and *Ohio*, of 12,400 tons, which belong to the programme of 1897-98. For the three ships however of the 1899 programme, the *Georgia*, *New Jersey* and *Virginia*, and the two ships of the 1900 programme, the *Rhode Island* and *Nebraska*, the superposed turret was again adopted. These vessels will displace 14,600 tons, and their armament will comprise four 12 in., eight 8 in., twelve 6 in., and some thirty smaller guns, which may be compared with the armament of our *King Edward VII.* class, consisting of four 12 in., four 9·2 in., ten 6 in., and about twenty-four smaller guns. The speed of the United States vessels will be about half a knot more than that of our new ships, the protection and coal capacity being about the same. As was said last month the programme of the present year includes two battleships of not more than 16,000 tons each, which may indicate that the system of superposed turrets is again to be abandoned. If we include the *Indiana, Iowa, Massachusetts, Oregon, and Texas*, with the fifteen ships just mentioned, we have the twenty battleships recommended by the Naval Policy Board of July, 1890.

The same Board recommended that there should be sixty cruisers in the fleet, and so far as armoured vessels of the class are concerned there are now thirteen completed, building, or projected.

THE DEVELOPMENT OF "WIRELESS" TELEGRAPHY.

BY

H. C. MARILLIER.

I.

THERE is a tendency, one that is inseparable from all epoch-making developments, to suppose that "wireless" telegraphy is a new thing, suddenly originated and offered to the world by a discoverer. The Röntgen rays, so called from the distinguished German professor who first discovered them, were exceptional, in that they had not been expected or predicted by theory, and consequently for a time they were not understood; but with our present subject there was no room for a surprise. Theory in that case preceded experiment, and the waves were being actually looked for by several experimenters.

MAXWELL'S THEORY.

For the basis of modern telegraphy without conducting wires it is not necessary to go back further than the memorable researches of Professor James Clerk Maxwell, of Cambridge, who in the early sixties demonstrated by mathematical and physical reasoning that an electric oscillation should send out electro-magnetic waves which are of the same order as waves of light and heat, and, in fact, form a continuous sequence with them, differing only in respect of their lower range of frequency and greater length, which prevent their recognition by our senses. Electricity, magnetism, light and heat are, in fact, merely abstract names for different manifestations of the same phenomenon, to which may be added a further series of effects due to waves of higher frequency than those of light, the photo-chemical, or ultra-violet, and the already mentioned Röntgen rays.

THE HERTZ EXPERIMENTS.

Maxwell's belief had for a time few followers outside this country, the Germans especially being wedded to a rival theory of action at a distance. It was, nevertheless, left for a German, the lamented Heinrich Hertz, who died in 1894, to put the crown to Maxwell's work by confirming experimentally the existence of such radiations and their behaviour in a manner like the visible ones of light. By means of suitable receivers, or "resonators," he intercepted and measured their length and frequency; showed that they could be reflected and deflected by metal surfaces, refracted by certain media, concentrated by lenses, impeded by glass or water, and even polarised. He proved, in fact, that they behaved in all respects like a beam of light, having, moreover, the same velocity of transmission, viz., 186,400 miles per second. Only in the frequency and amplitude of their vibrations, which govern the physical effects they are capable of producing, is there any essential difference. The form of detector employed by Hertz in his experiments to intercept the invisible rays he was dealing with was a split metal ring, with the ends capped by two small balls which nearly touched. When a spark from a Leyden jar or oscillator was allowed to start vibrations in the neighbourhood of such a ring, surging currents were set up in it corresponding in duration to the length of the disturbance, and these manifested themselves by a secondary spark between the little balls.

Hertz's results, published in 1888, attracted wide attention, especially amongst those who had already been working at Maxwellian waves, of whom the late Professor Fitzgerald, of Dublin, and Dr. (now Sir) Oliver Lodge were amongst the most prominent. The chief outcome of their labours and others, since then, has been an immense improvement in the sparking apparatus used to start the vibrations, and a multiplication of suitable forms of detectors, many of them of greatly increased sensibility. These two pieces of apparatus form the essential elements in modern "wireless" or—as the correct Germans prefer to call it—"spark" telegraphy, and their development will be dealt with separately.

SIR OLIVER J. LODGE, D.SC., F.R.S., LL.D.,
Principal of the University of Birmingham.

"WIRELESS" TELEGRAPHY A BYE-ISSUE.

Meanwhile it is necessary to remark that telegraphy across space was only a bye-issue of the researches with Hertzian waves; Hertz himself paid no attention to it, though the application was obvious, and of his successors who did, most were concerned at first with the scientific rather than the practical aspect. Nevertheless, the question of signalling across space without connecting wires had arisen at a fairly early date, and electrical workers had been engaged upon it. Speaking generally, the earliest experiments had no reference to ætheric vibrations whatever, but were attempts to utilise the known leakage of electric currents through the earth and through water, to communicate between more or less distant points.

PRIMARY FACTS.

A diagram will explain this system clearly. A and B are metal plates sunk in the water at two points on one side of the river Thames, and connected by an insulated wire. C and D are corresponding plates also connected on the opposite side. If a current is passed through the wire A B it uses the earth, and more particularly the water, as a return circuit, spreading out in the manner shown by the dotted lines. A portion of the current spreads as far as the metal plates C and D, and passing into the wire which connects them, will give faint, but perhaps intelligible, signals. When a storm once destroyed the cable connecting the island of Mull with the mainland the telegraphists actually used this method of signalling, the ends of the overhead land wire on the island being dipped into the sea, whilst at Oban a wire a mile and a-half long was laid along the shore and dipped into the sea in a corresponding manner. Communication was thus kept up for over a week across a strait two miles wide. Experiments of this kind were made by Morse, the father of telegraphy, as far back as 1842, and were continued down to 1894, the introduction of the Bell telephone in 1877-8 providing experimenters with the most sensitive receiver that could possibly be devised for making small currents perceptible, and giving a considerable impulse to their attempts.

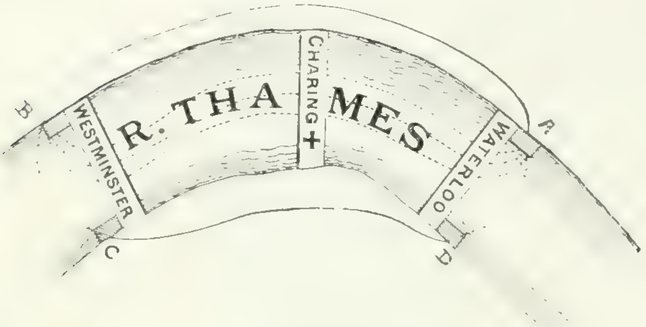


DIAGRAM SHOWING EARTH CURRENTS.

EARLY EXPERIMENTS.

Under the influence of this renewed activity, Mr. (now Sir William) Preece conducted a long series of experiments between the Isle of Wight and the mainland, and later at Penarth, and across the Kilbrennan Sound, between Kintyre and the Isle of Arran. The distances traversed in this way were from four to six miles, to accomplish which land-lines of several miles in length were required. The system in fact was far from economical, and is chiefly interesting nowadays from a historical point of view. Perhaps the most successful attempt to cope with its possibilities was that made by Dr. Rathenau and Professor Rubens in 1894, across the open waters of the Wannsee, near Potsdam. Using sunk metal electrodes and a base-line about 550 feet long, these experimenters succeeded in signalling three miles, the current generator being a battery of 75 accumulators with a rotating interrupter. The receiver was a telephone, from which messages were read off in the usual dot and dash code. Earth currents, as a mode of communication, are employed in one of the latest competing systems of "wireless" telegraphy (the Orling-Armstrong) as well as in the earliest experiments, and will be referred to once more in this connection in a subsequent article.

ELECTRO-MAGNETIC INDUCTION.

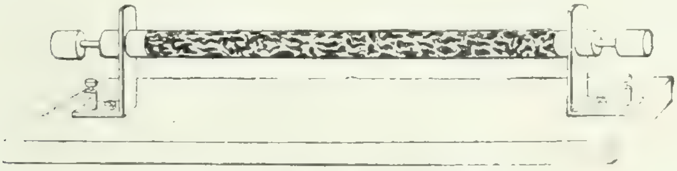
A more promising method of signalling across a distance without conducting wires appeared, and still appears, to be offered by the phenomena of electro-magnetic induction. A varying or alternating current in a wire circuit has the property of inducing a corresponding current in another circuit near it. This is the principle of the ordinary transformer, in which, however, the two circuits are packed as closely together as they can be and provided with a metallic core to render the losses of transformation as small as possible. In telegraphy the object is to get the circuits as far apart as possible, and yet preserve economy, which can only be done to a limited extent without the use of special devices. The most important of these are associated with the name of Sir Oliver Lodge, whose work, dating from about 1889, will be described presently. Practical experiments with induction were also carried out by Sir William Preece at several points and in several ways in 1893, and his results were summarised in a paper read by him before the Chicago Congress. In many of his experiments earth-completed circuits were used, and there is little doubt that earth conduction currents as well as induction played a part in the performance. On one occasion at least, however, two quarter-mile squares of insulated copper wire were used, in such a way as to preclude earth currents, and with these, by means of rapidly-interrupted or vibratory currents, signals were transmitted inductively over a distance of about a quarter of a mile.

ACCIDENTAL CLUES.

The extraordinary range covered by certain accidental occurrences, as when signals passing in a Langdon-Davies phonopore circuit, with very high frequency currents, have caused disturbance in telephones 100 miles away, gave reason to suppose that much might be done with properly constructed apparatus; and it is on record that an offer was made, if £10,000 were forthcoming, to establish communication by this method with the Cape. Probably the main reason why nothing on a large scale was attempted was that just about that time the method of signalling with Hertz waves came into prominence and eclipsed it.

AERIAL ELECTRIC WAVES.

It would not be easy to determine who first discovered the action at a distance of aerial electric waves. Joseph Henry, the Faraday of America, had got signals between the attics and the cellar of his house, by means of sparks, before Maxwell had even propounded his theory; and other old records of similar kind might be instanced; but their significance remained unrecognised. After the publication of Hertz's and Lodge's experiments many such observers came forward with recollections of facts bearing on the subject which had puzzled them at the time, or which they had taken note of. Probably the most important of such old observations (though they were never published) were those of Professor Hughes, the inventor of the microphone, which to this day remains one of the most sensitive devices for detecting Hertzian waves. Long before Hertz had published his researches, or begun them, Professor Hughes was working at Hertzian waves, trying to determine their nature and to employ them practically for messages. In 1878 he described, in a paper read before the Royal Society, "a tube filled with loose filings of zinc and silver," which served as a detector, and which was the origin of the Branly coherer of twelve years later. In 1880 he demonstrated the actual transmission of signals to the President of the Royal Society, Mr. Spottiswoode, and the two hon. secretaries, Professor Huxley and Professor G. Stokes. The last-named gentleman, however, was unwilling at that date to accept the phenomena as due to aerial waves, and attributed them to electro-magnetic induction, whereupon Professor Hughes became discouraged and dropped the subject. After Hertz, with his far more masterly researches, had solved the entire problem in 1887-9, Professor Hughes felt, he says, in a letter to the *Electrician* in 1889, "that it was too late to bring forward his previous experiments, and through not publishing his results and the means employed, he was forced to see others re-make the discoveries he had previously made as to the sensitiveness of the microphonic contact, and its useful employment as a receiver for electric aerial waves."



AN EARLY FILINGS COHERER.
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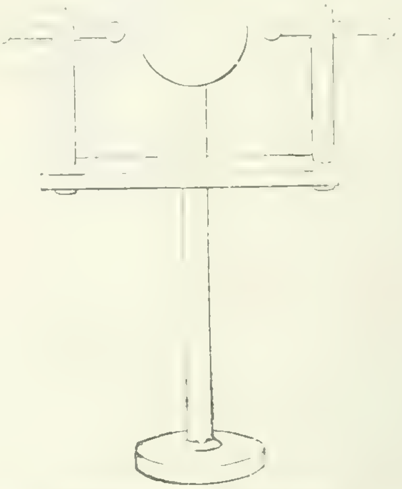
DR. LODGE'S EXPERIMENTS.

A more fruitful series of experiments was that of Sir Oliver Lodge, already mentioned, at Liverpool. Lodge had been working at oscillatory discharges and electro-magnetic waves before Hertz, and had partially anticipated Hertz's discoveries. He obtained evidence of waves running along wires, starting from an oscillating or spark circuit, and measured their length. His first successful signalling results, however, were published in 1889, and were carried out with what he called "syntonic" circuits—closed circuits containing Leyden jars, and tuned by means of a sliding resistance in such a way that the receiving circuit is far more sensitive to induction from the transmitting system than would ordinarily be the case. The first application of the "coherer" principle formed a part of this experiment, the overflow spark from the syntonic Leyden jar at the receiving end taking place between two balls placed so close together that after the passage of the spark they remained in actual contact. This cohesion of bodies following a spark is an old discovery, due perhaps to Guitard, who in 1850 found that particles of dust adhered to each other in the presence of an electrified body. The massing of rain-drops during a thunderstorm is attributable to the same cause. While the two balls were in contact no further spark could pass, and so in order to repeat the signalling action it was necessary to have some tapping apparatus to make them come apart. Such an apparatus, acting automatically, formed part of Dr. Lodge's original 1889 experiments, and consisted simply of an electric bell and battery in the circuit. The bell was placed on the same platform as the stand containing the balls, and its vibration every time the balls allowed a current to pass was sufficient to break the cohesion. A sort of make-and-break action was thus set up between the coherer and the bell. "Coherer" was Dr. Lodge's own term for the apparatus. Another form which it took in his experiments was a point in contact with a spring, which recalls the microphone joint, and forms a highly sensitive arrangement.

THE BRANLY COHERER.

M. Edouard Branly, of Paris, however, discovered in 1890 the property of metallic powders, filings, etc., to act as detectors of spark waves; and his form of coherer, which down to a recent date has held the record for sensibility, was finally adopted by Dr. Lodge for work with Hertzian waves, in preference to any other. The first notice of Branly's coherer, in which its action was described but not explained, appeared in *Comptes Rendus*, November 24th, 1890, and may be summarised as follows: A glass tube, containing metal filings between two metallic conductors, is placed in circuit with a Daniell's cell and a galvanometer. Owing to the high resistance of the filings no current can pass. As soon as a spark passes in the neighbourhood of the tube from a Wimshurst machine, or Ruhmkorff coil, the resistance of the filings drops from several million ohms to 2,000, or even to 100 ohms, and a current is registered on the galvanometer. The action had been shown to take place at 20 metres distance, through opposing walls or floors. M. Branly made several further discoveries of the same nature, with variations of his material, but although the credit for the fundamental discovery is his, most experimenters have adapted his coherer in their own way to suit their own ends. Dr. Lodge applied to it his automatic tapping arrangement already described, without which its receptive properties come to an end after the first impulse. He also improved its sensitiveness by placing the grains of metal in a vacuum, or occasionally in hydrogen. A further addition to the receptive properties of the Branly coherer, first employed by Lodge in his earlier forms, is the use of metal streamers, or "antennæ," to intercept a greater range of vibrations, and also to tune the circuit of the receiver. Finally, it was Dr. Lodge, in conjunction with his co-worker, Dr. Alexander Muirhead, the well-known telegraph expert

DR. EDOUARD BRANLY.



LODGE'S EARLY RADIATOR.

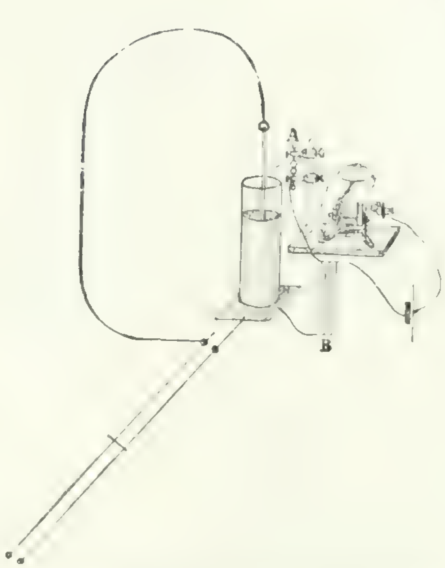
(From "The Work of Hertz," Electrician Publishing Co.)

Wireless Telegraphy.

who first applied the automatically tapped coherer to convey dot and dash signals, sent as interrupted Hertz waves, to a telegraph instrument. He, in fact, used it as a relay to make the distant oscillations operate an electric bell, a Morse sounder, or a siphon recorder. His transmitter or radiator was an arrangement shown in outline, of one or more large spheres between two knobs, which has since been considerably improved by Professor Righi, of Bologna, who interposed a layer of oil between the two central balls, thus keeping their surfaces clean and assisting in the production of sharp snappy sparks. Righi's oscillator, connected with a 10 in. induction coil, is the instrument most generally employed in transmitting Hertz waves over moderate distances.

SYNTONISING.

An account has been given of Lodge's special contributions to telegraphy with Hertz waves, because some of them have since proved to be essential elements of success, and have been adopted by later exponents; but Lodge's own preference seems to have lain throughout in the direction of magnetic induction, rendered practicable by the special devices already referred to. Of these the most important is his method of "syntonising," or tuning the transmitting and receiving circuits so that the inductive effect is enormously magnified. In a paper read before the Institution of Electrical Engineers in December, 1898, Sir Oliver Lodge gave a full description of this system and of his earlier experiments with it. Instead of Leyden jars, he placed in his two circuits condensers of large capacity, syntonised to respond to vibrations of the same period. In the transmitting circuit was a small alternator, giving a frequency of vibration of 384 per second (in place of the million or so appropriate to Leyden jars), so that the resulting waves came within the region of audible sound. The receiving circuit, therefore, contained no coherer, but simply a telephone, placed in shunt to the condenser. The circuits were insulated wire enclosures embracing about 400 square yards, distant two miles apart. Owing to the initial difference of potential between the terminals of the receiving condenser, the effect of sympathetic oscillations is cumulative, and may produce an electromotive force of many thousand volts, capable of bursting the condenser. The action is compared by Sir Oliver Lodge mechanically to that of a heavy truck pushed backwards and forwards on a pair of rails. If the truck be held by elastic springs before and behind (comparable to the tension between the condenser terminals) it acquires an inertia of swing under the influence of properly timed pushes, and with small expenditure of power may gradually become the centre of enormous energy. The condenser in the transmitting circuit tends to reinforce and also to steady the vibrations of the dynamo current.



LODGE'S SYNTONIC RECEIVER AND TAPPER.
([illegible])

SURPRISING EXPERIENCES.

With this apparatus Sir Oliver Lodge had some surprising experiences. He could not only intercept, but effectually deranged all the telephone messages in the neighbourhood of Liverpool, and his working was occasionally perceived a hundred miles away. This, of course, was a disadvantage in a busy industrial centre, and means had to be taken to render the system innocuous. What these means are have not been disclosed, but it is understood that Sir Oliver Lodge and Dr. Muirhead have been perfecting the system, the essentials of which were patented in 1897, and that magnetic induction may yet come forward as a rival to spark telegraphy in the competition for long distance communications.

(*To be continued.*)

SIR ANDREW NOBLE AND ELSWICK.

A Biographical Sketch.

IN the early autumn of 1860 Lord Armstrong took one of the most judicious steps of his career, and invited Captain Noble, a young officer already recognised as an expert in artillery matters, to join his newly-formed ordnance works at Elswick. Forty years have elapsed since that offer was made, and, in a fortunate hour for Elswick, accepted. To-day, Captain Noble has become Sir Andrew Noble, and is the chairman of Sir W. G. Armstrong, Whitworth and Co., Ltd. All the later extensions and developments of the business have been carried out under his direction, and time has done nothing to diminish his energy and activity, both in the interests of the firm and in the advancement of the science to which he has devoted himself.

Sir Andrew Noble was born at Greenock in 1832. His father was a naval officer, the scion of a Dumbartonshire family, whose estate, lost for a generation, was repurchased in 1889 by the subject of this sketch. Having completed a course at the Edinburgh Academy, Sir Andrew passed through Woolwich and received in 1849 a commission in the Artillery, afterwards serving with his regiment in Malta, Canada, and South Africa. He was especially attracted by mathematical studies and scientific research. In 1858, upon his return from the Cape of Good Hope, he acted as secretary to the Royal Artillery Institution, and the same year was appointed Secretary to a Special Commission upon Rifled Cannon. His increasing reputation as an expert caused him to be nominated by the War Office to various positions in connection with the subject of guns and their ballistics, and he was Assistant Inspector of Artillery when, as we have mentioned, Lord Armstrong invited him to join the Elswick Works.

It may not be uninteresting at this point to recall the main facts connected with the history of the firm. It was as long ago as 1847 that Mr. William Armstrong opened a modest factory at Elswick, in which to manufacture his hydraulic cranes. He was at the time a partner in a solicitor's business in Newcastle, but his leisure hours had been devoted to mechanical and electrical experiments, and he was already known as an inventor of boldness and originality. Assisted by four of his fellow townsmen, who joined in subscribing the £20,000 of capital required, he bought a couple of meadows on the banks of the Tyne, and started his hydraulic engineering works. Shortly after the opening, the Armstrong cranes had the good fortune to attract the notice of the engineer of the Liverpool docks, Mr. Hartley, and were adopted by him. Increased custom followed, and the business was in a prosperous state when, some eight years after its inception, the attention of its founder was directed to a new sphere of invention. The outcome of this new departure was the Armstrong gun, which, brought to the notice of the authorities during the Crimean War, gained for itself, after many competitive trials, the favour of the Government and was accepted as the service weapon. In later life, Lord Armstrong used to protest that he only took up the study of artillery as a hobby, suggested by the martial ardour of the moment, and that he had hardly any notion of turning his ideas to practical effect. But he attacked the subject with characteristic energy and concentration, and the result was an increased reputation for himself, and an altered destiny for his works at Elswick.

Under arrangements which were too complicated to prove satisfactory, Mr. Armstrong entered the service of the Government in order to superintend the making of his new guns at Woolwich. At the same time, to assist in meeting the demand, artillery works were started at Elswick, where, it must be remembered, there was already a staff of skilled operatives with experience in this manufacture. Though these shops were side by side with the existing engineering works, the two concerns were kept separate. The hydraulic business continued as before, and the Elswick Works commenced as a Government arsenal, bound by agreement to make guns for no other Power but England. The utmost secrecy was preserved, and the intrusion of foreign observers was rigorously prevented. Lord Armstrong, to give him his title of later life, possessed in a marked degree one characteristic of the successful leader. He chose his subordinates with foresight, and seldom made mistakes in his estimate of ability. We have already referred to Sir Andrew Noble in this connection, but in the early years of his engineering enterprise, Lord Armstrong owed much to the capable assistance of Mr. Percy Westmacott, and when the ordnance works were started, he appointed a manager of great ability in Mr. George Rendel. Both these gentlemen are still directors of the company which owes so much to their efforts, but both have long since retired from active management.

In 1860 the shops at Elswick were crowded with Government orders, and the fortunes of the place seemed tolerably assured. Within the short space of three years the conditions were entirely altered. The contracts ceased, the ardour of the Government cooled, and the authorities paid the Company a sum of money to close the arrangements which had been made. Lord Armstrong resigned his Woolwich appointment and returned to Elswick, where the workshops, equipped with costly machinery, stood almost empty. The engineering works and the ordnance works were united into one concern, and the partners commenced to establish

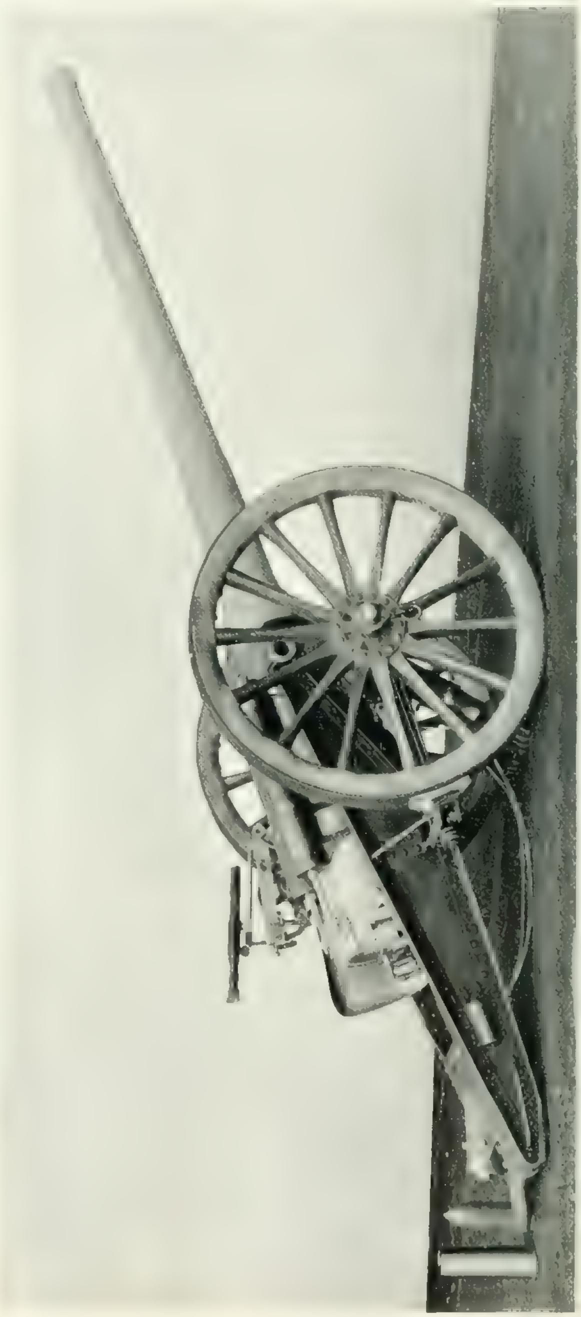
THE JAPANESE WARSHIP "YASHIMA" PASSING THROUGH THE HIGH LEVEL BRIDGE AT NEWCASTLE.

a foreign connection. The War Office has been the hero of many singular proceedings, but one of the most mysterious episodes in its history was its complete neglect for nearly fifteen years of the technical resources which were ready to hand at Elswick.

During this period of official stagnation, the science of artillery was making rapid progress under Lord Armstrong, Mr. George Rendel, and Sir Andrew Noble. Yet it was not until the Russian war scare of 1878 that the Government purchased four 110-ton guns, built for the Italians, and passed them into our own service. Nor was it until more than twenty years had gone by since the desertion of 1863, that the Elswick experts finally succeeded in forcing upon the attention of our own authorities the new type of gun, which is now everywhere adopted.

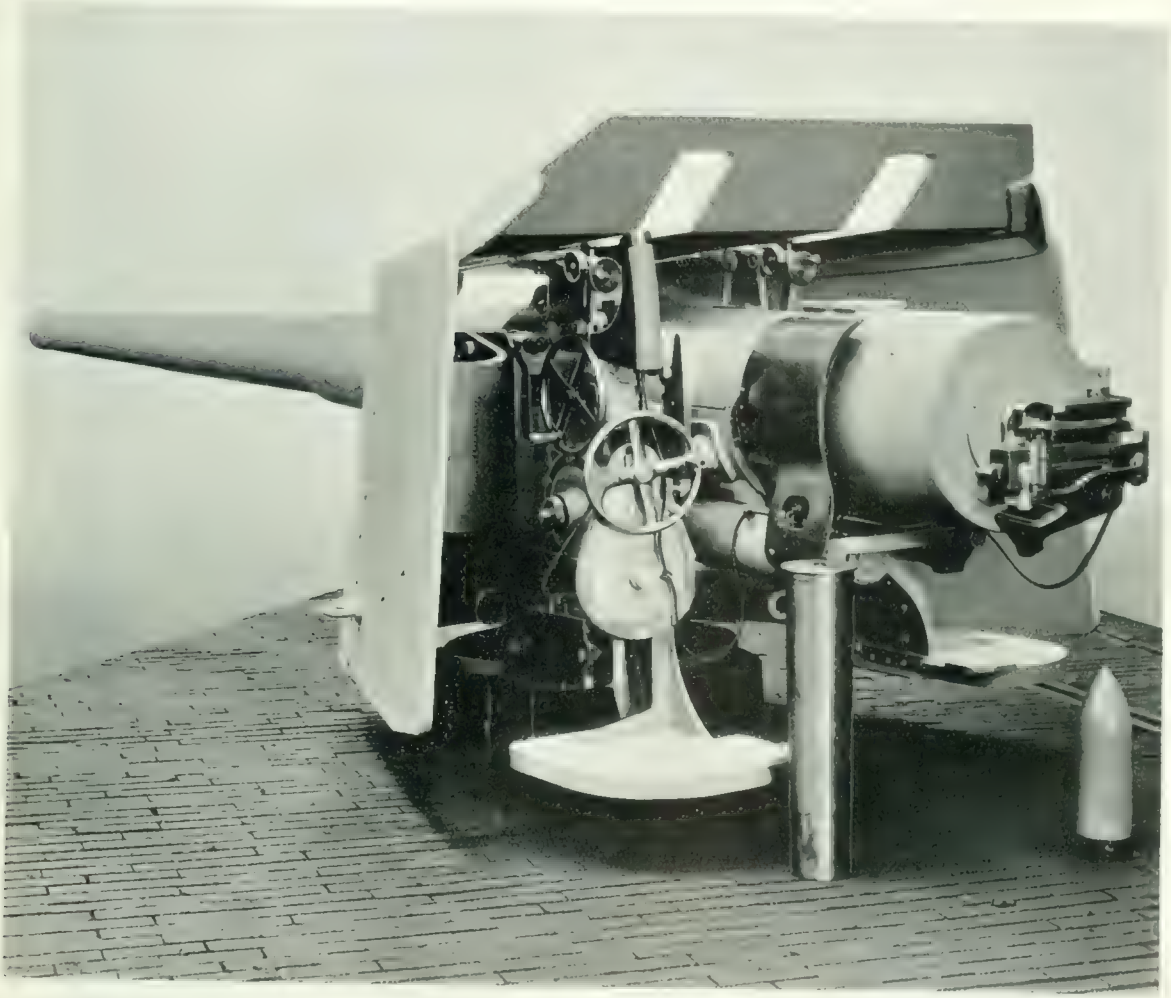
Particulars of the advance in gun designing and construction are no doubt familiar to many, but may be briefly recapitulated. The original Armstrong six-pounder gun was made of coiled wrought iron cylinders, shrunk upon an inner barrel, which was at first of steel. It was a breech-loader, with a breech-block screwed in, and was rifled upon the polygroove system, with a uniform twist. Subsequently, certain steps, which appear to us retrograde, but which were doubtless necessitated by the conditions of the period, were taken. Steel was given up on account of its unreliable nature, and a return was made to muzzle loading. The Armstrong system of construction, however, opened the way for an exceedingly rapid increase in the size of guns, so that in 1875 we had guns of 100 tons weight.

Meanwhile, Sir Andrew Noble was bringing to bear upon the subject an amount of accurate research hitherto unknown. He began by experimenting with closed cylinders in which charges of powder were fired by electricity, pressures were recorded, heat determined, gases analysed, and the products of explosion examined. He also invented the chronoscope, which bears his name, for ascertaining the velocity of a projectile in the bore of a gun. This was quite novel work, and was soon to take a practical shape. The old gunpowder was changed, and a powder, burning regularly and slowly, took its place; steel, the manufacture



LATEST PATTERN 4.7 IN. QUICK-FIRING GUN.

of which had been greatly improved, was re-employed as the proper material, and gradually the new type of gun was evolved. These facts are, of course, the common-places of history, though, in the glare of latter day advertisement, the pioneers are apt to be sometimes obscured.



LATEST NAVAL 6 IN. QUICK-FIRING GUN.

We reproduce photographs of the latest patterns of 12-pounder, 4·7 in. and 6 in. quick-firing guns. In addition to the increased length of the bore, features common to quick-firing guns will be noticed in the photograph—the breech mechanism with its interrupted screw and single-motion action, the hydraulic recoil presses, and the absence of trunnions on the gun, which recoils in a cradle.

The first gun known as Quick-firing was the 4·7 in. gun made in 1886. It was employed for the armament of the Italian cruiser *Piedmonte*, built at Elswick in 1889. The 4·7 in. gun shown in the photograph is mounted on a travelling carriage for field service, and the following are its dimensions and ballistics. Total length, 194·1 in.; weight, 42 cwt.; charge, 5 lbs. 7 ozs.; projectile, 45 lbs.; muzzle velocity, 2,188 foot seconds; energy, 1,494 foot tons. It can fire ten rounds per minute.

The naval 6 in. quick-firing gun illustrated is

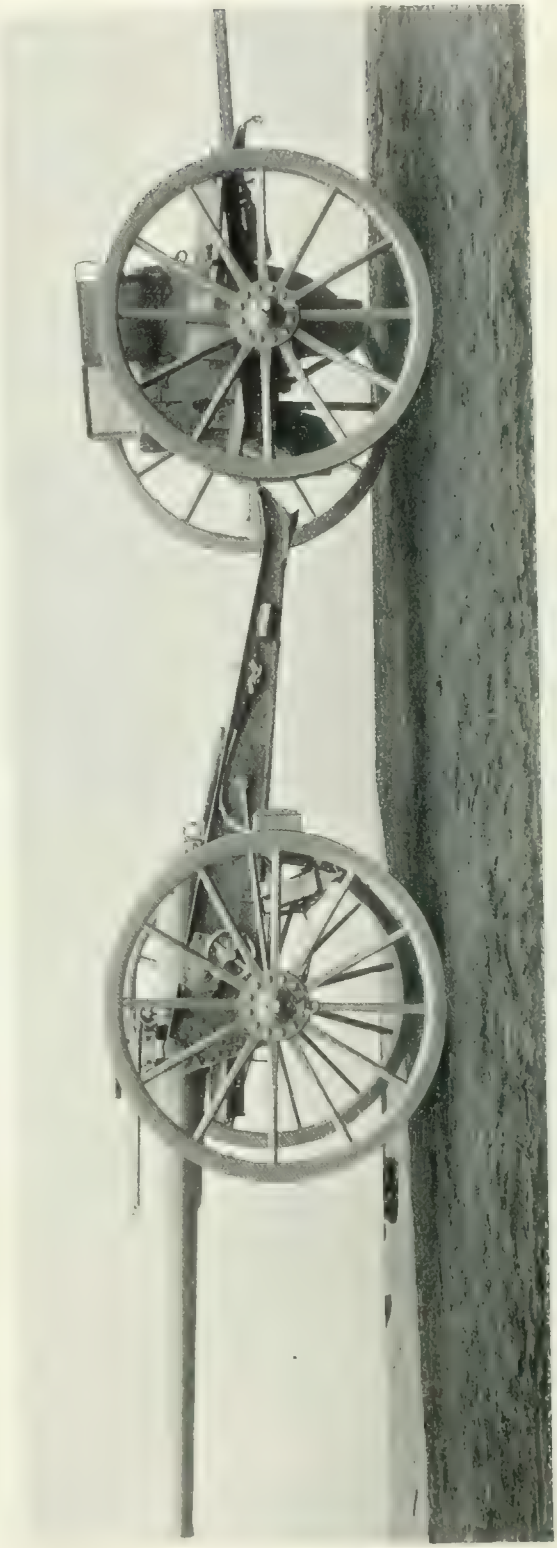
249·25 in. long, and weighs 6 tons 12 cwt. The charge is 15 lbs., and the projectile 100 lbs. The muzzle velocity is 2,300 foot seconds, and the energy 3,668 foot tons. Six-inch guns are constructed up to 50 calibres, or 300 in. in length, and with the increased length of bore, velocities up to 3,000 ft. are obtained.

The 12-pounder quick-firing gun is interesting as being a gun from the battery presented by Lady Meux to Lord Roberts in 1900, and used by the Elswick Battery in the South African campaign. The total length is 123·6 in., and the weight 12 cwt. The charge is 1 lb. 15 ozs. and the projectile 12 lbs. 15 ozs. The muzzle velocity is 2,210 foot seconds, and the energy 423 foot tons.

Turning now to some of the other developments of Elswick, we revert to 1869, when Mr. George Rendel designed the gunboat *Staunch*, and the attention of the company was directed to the building of warships. These were first constructed according to Mr. Rendel's designs in the shipyard of Mr. Charles Mitchell, at Walker-on-Tyne, and when in 1882 the firm became a limited company, Mr. Mitchell's yard became part of the business, which was entitled Sir W. G. Armstrong, Mitchell and Co., Ltd. In 1884 a second shipyard, exclusively for war vessels, was opened at Elswick, under Mr. White, who, as Sir William White, afterwards filled the position of Naval Constructor at the Admiralty. Mr. White, upon being appointed to the Admiralty, was succeeded by Mr. Philip Watts at Elswick, on October 1st, 1885.

The cruisers and battleships from Elswick, of high speed and heavily armed, have strengthened many navies, and are inseparably associated with the genius of Mr. Watts. The photographs given with this article show the passage of the Japanese battleship *Yashima* through the High Level Bridge at Newcastle, in June, 1896, the launch of H.M.S. *Lancaster*, and the Chilian 30-knot torpedo-boat destroyer *Capitan Thompson*.

Space prevents the insertion of full particulars of these ships, and prevents also the enumeration of many other well-known



12-POUNDER QUICK-FIRING GUN.

Used by the Elswick Battery in the South African Campaign.

Photo by Elliott and Fry.]

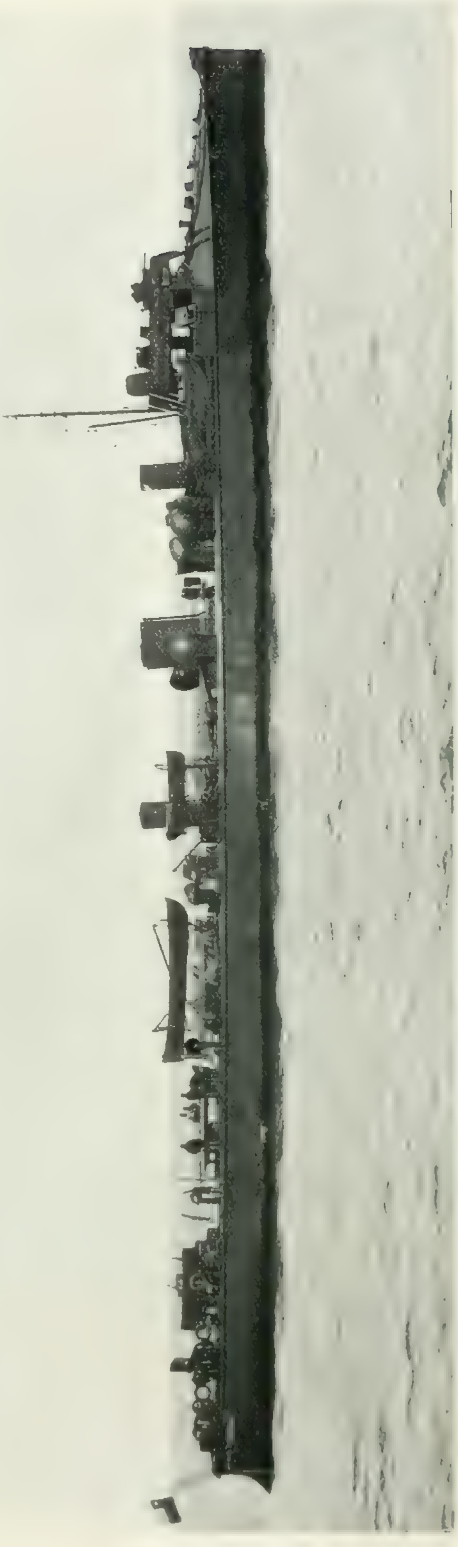
SIR ANDREW NOBLE, BART., K.C.B., F.R.S.

armour-clads and cruisers which have issued from the same yard. Mr. Watts left Elswick in 1902 to succeed Sir William White as Director of Naval Construction at the Admiralty, the highest position that a Naval architect can obtain.

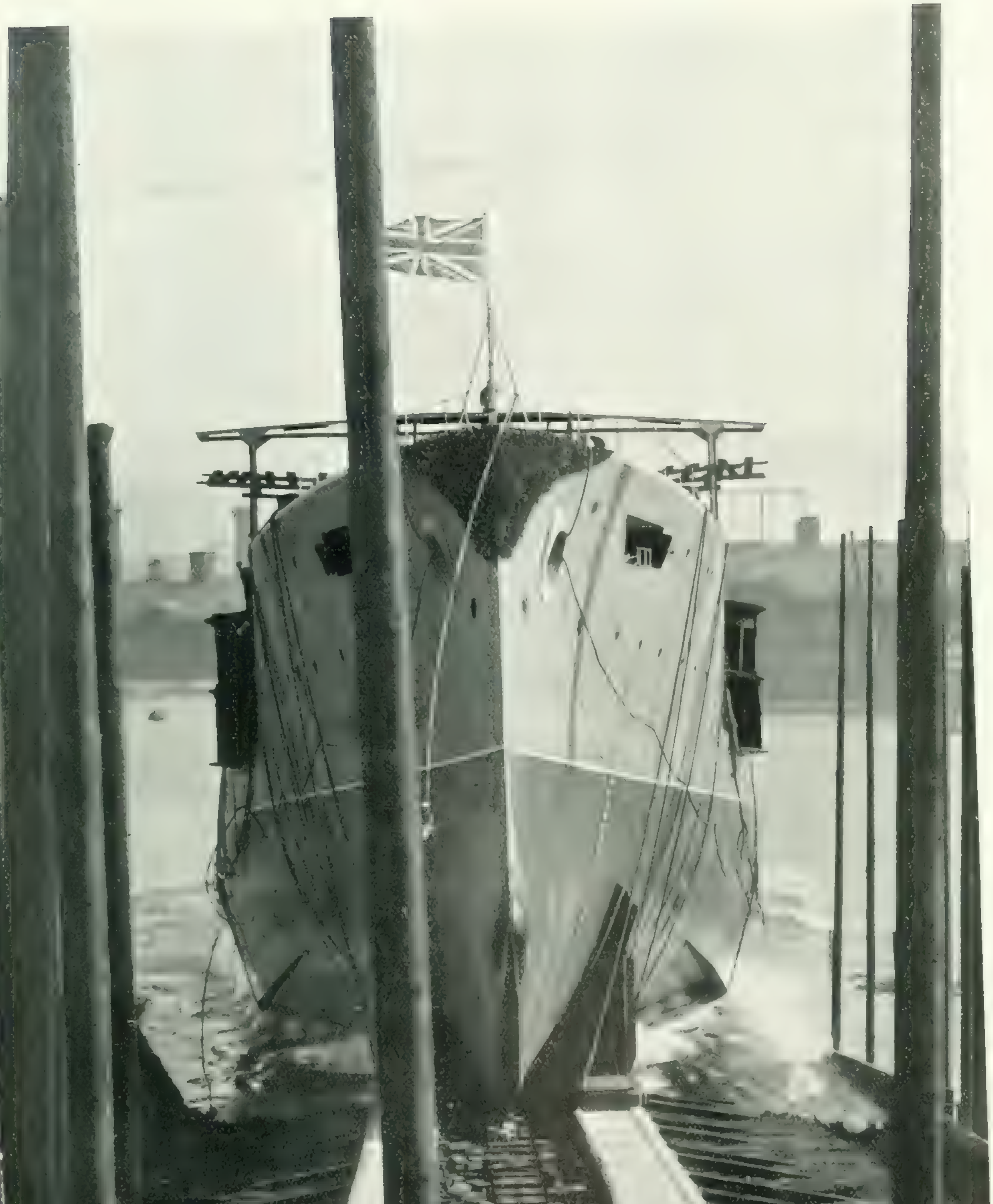
As the Elswick Yard is devoted to warships, the Walker Shipyard of the company confines itself chiefly to the construction of merchant vessels. Among the most interesting of these is the ice-breaker *Ermack*, whose services to Russian commerce in frozen seas have been widely portrayed in journals and magazines. A speciality has also been made of tank steamers for carrying petroleum in bulk, under the patent of Mr. Henry Swan, the present head of the yard. The patronage for many years of the Italian Government led to the establishment of a branch arsenal at Pozzuoli, on the Bay of Naples. This arsenal is used for Italian work, and employs more than a thousand hands. Another undertaking, almost inevitable for a business where so many heavy steel castings and forgings are needed, was the starting of the Elswick Steel Works, under the late Colonel Dyer, in 1882.

The most important step resulting from the forward policy of the Company was, however, the amalgamation with Sir Joseph Whitworth and Co., in January, 1897, combining under one title the names of two engineers, each great in his own line, and at one period vigorous rivals—the late Lord Armstrong and the late Sir Joseph Whitworth. The Openshaw Works may be said to have the advantage in point of seniority over Elswick. Mr. Whitworth, it may be remembered, after working at Maudslay's, Holtzapffel's, and Clement's, returned to Manchester in 1833, and put up a sign—"Joseph Whitworth, Tool Maker, from London." From this workshop has grown up the large manufacturing establishment at Openshaw, where are steel works, gun works, and shops for making machines. Finally, a plant for making armour plates for ships has been started here within the last year or two.

The Armstrong, Whitworth Company can turn out a battleship fully armed and armoured,



CHILIAN 30-KNOT TORPEDO-BOAT DESTROYER "CAPITAN THOMPSON." BUILT AT ELSWICK.



LAUNCH OF H.M.S. "LANCASTER."

though not engined, as they have not yet taken up marine engineering. Among their other productions, in addition to guns, mountings, and projectiles, are merchant vessels, steel of all kinds, machinery, electrical and hydraulic machinery. The Company's shops cover 224 acres of ground; it employs about 25,000 men and pays £30,000 a week in wages.

In the course of his long career and association with the works, Sir Andrew Noble has naturally received numerous honours. He was created a C.B. in 1881, and K.C.B. in 1893, and a Baronet of the United Kingdom in 1902. In 1870 he was elected a Fellow of the Royal Society; and in 1880 received the Royal Medal of that Society. He is a Knight of various foreign orders, and has been honoured by many learned and scientific bodies. For the past two years he has served with Lord Rayleigh and Mr. Haldane, M.P., upon the Explosives Committee.

SIR ANDREW NOBLE IN HIS LABORATORY.

Probably few men have wider sympathies, or a more catholic taste, than Sir Andrew Noble. His popularity among those who work under him at Elswick is immense; his circle of friends is wide, and he is never happier than when surrounded by them in his beautiful place at Chillingham.

In his youth an athlete of distinction, there is hardly a form of sport or game which he does not patronise and support with enthusiasm, and, when necessary, with generosity. He owns one of the few private tennis-courts in England, and many thousands of acres of partridge and pheasant shooting, both in Northumberland and Norfolk. He is a fine shot, but was debarred by an accident from indulging in this form of sport last season.

Sir Andrew is a man of wide reading and culture, versed not only in scientific, but also in general literature. Of the two accompanying photos, one is by Messrs. Elliott and Fry. The other is furnished by an accomplished amateur, who had the privilege of taking Sir Andrew while at work in his chemical laboratory.

IRON AND STEEL MANUFACTURE.

TRANSPORTATION OF MINERAL FROM FURNACE STOCKYARD TO MOUTH OF FURNACE.

BY

B. H. THWAITE, C.E.

The Author in the two preceding Articles dealt with the choice of a site, the selection of ores, and the most economic methods of transportation.—Ed.

III.

STOCKING THE MINERALS.

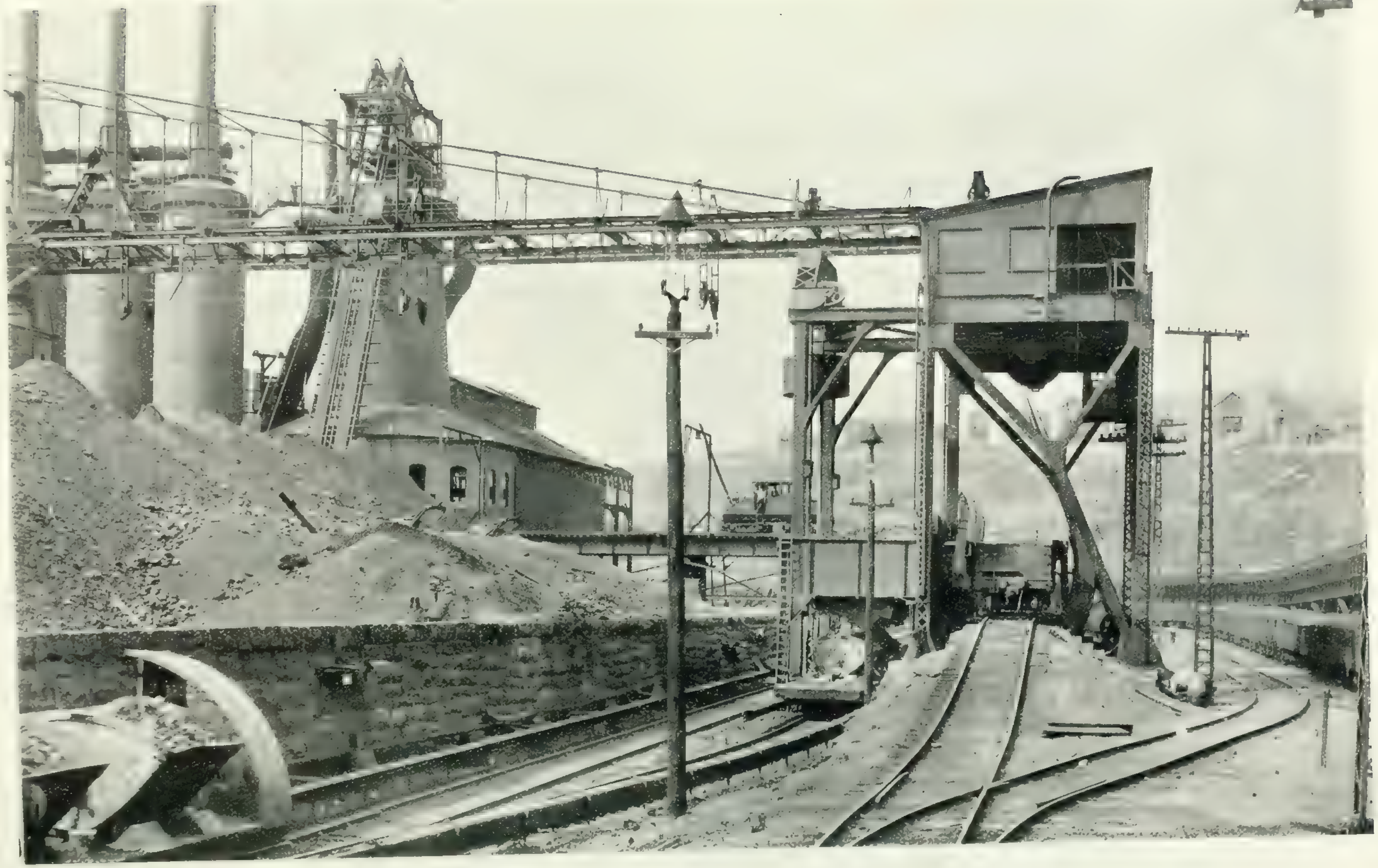
THE system adopted, by which the car is cleared of its contents, is a development of the tipping method in use in many of our coal-shipping ports, with this important difference, that in the American system not only is the car discharged by being overturned, but the operation is effected in such a way that the mineral is actually deposited at a higher level.

On referring to the illustration on page 276, it will be seen that part of the railway track, or siding, is detachable, so that it can be bodily lifted with its car load. The detachable track is mounted on a cradle-like structure, U-shaped, as heavily constructed as would be an ordinary plate girder bridge, because the dynamic programme involves not only the overturning of the car and its contents, but also its bodily lifting. It will be noticed, on referring to the figure, that the cradle track is mounted on a heavy shaft of 10 in. diameter, around which it is bodily turned or rotated through a section of a circle.

The motion of the tilting cradle is effected by means of steel wire cables that pass under the framework of the cradle structure, and around the drum of an electric winding engine located in an engine-house, directly and substantially superposed over the track tilting cradle.

A counterbalance weight is provided in order to assist in overcoming torque and inertia effects. The counterbalance weight not only comes into action for the purposes described, but it serves as a brake when the track cradle has passed into the zone of gravity influence, and in such a way that the weight of the car in falling by its own gravity is taken up by the counterbalance weight, which is consequently lifted or hoisted, and in its suspension constitutes a rapidly effective source of reserve energy to assist the electric motors in lifting the track cradle and its ore contents. Before the track cradle is put into motion it is rigidly held by a simple hydraulic clamp, adjustable for use with mineral cars of the largest capacity and under.

The ore or mineral contents of the car, when tilted, fall on to an inclined steel plate, by which they are diverted or deflected into a steel bin of ample capacity for receiving the contents of two of the maximum capacity cars.



HIGH CAPACITY MINERAL TILTING CRADLE AND ORE BINS.

Showing a portion of the Brown Hoisting Crane, Stockyard, and Electric Bucket Car Siding; also illustrating the Furnace and two Stoves.

The high structural efficiency of the large capacity 40 to 50-ton cars makes this system of discharging most effective and rapid ; for instance, one ordinary tilting apparatus will discharge a 50-ton car in two minutes. This is equivalent to an hourly capacity of car discharge—including the lifting of the ore—of 1,500 tons, and the reception bin capacity should be of equivalent proportions, because it is quite obvious that the bin discharge must be as rapidly effective as the operation of charging. The bins can, of course, have twin discharge doors, one on each side, the floors of the bins inclining towards each discharge door.

The bins are longitudinally divided into two compartments of a size proportionate to the capacity of two electrically propelled cars, that travel directly under the bins and their discharge doors. Each car carries two specially constructed buckets. To differentiate these cars and their buckets, they will be referred to in this article as bucket cars. The bucket cars are the agents by which the mineral is transferred to the stock heap.

The bins are divided into compartments, so that the discharge can be proportioned to the capacity of the buckets provided for receiving the mineral. The bin discharge doors have independent actuating gearing, electrically driven, and any one of the discharge doors can be put in motion from one point. Each of the compartments has a storage capacity of some ten tons.

The bucket cars—heavily constructed—are independently electrified, collecting their energising current from side conductors, consisting of guarded iron bars, on which slide the contacts as shown in the figure. The bucket car sidings are so arranged that the discharged bucket cars can be shunted out of interference with the movement of the full cars—the switches being self-operating, either by the assistance of rising grooves or by springs—so that the cars, in their movement past the location of discharge, are automatically diverted on to a siding that brings them round to the bins, the operations thus being continuously cyclical. Two bucket cars are generally coupled together. One of them is provided with a steel guard or cover under which a man controls the movement of the bucket cars.

Each car has places for two buckets, position or seating blocks being provided for maintaining the buckets in position. Only three full buckets are actually carried by the two cars. The fourth bucket location is provided to permit the bucket car, after discharge, to be returned to the bins with the least possible loss of time. The vacant location receives the empty bucket left by the preceding cars, because the bucket cars return to the ore bins when the last bucket has been lifted from it by the overhead traveller crane. A sectional view of the bucket is shown in fig. 1.

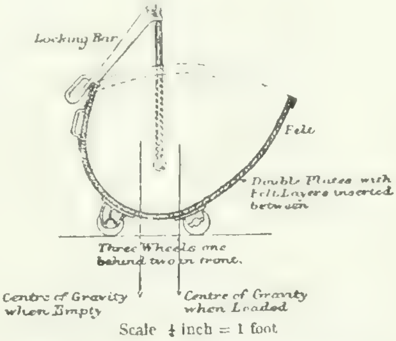

Locking Bar
Felt
Double Plates with Felt Layers inserted between
Three Wheels one behind two in front.
Centre of Gravity when Empty
Centre of Gravity when Loaded
Scale ¼ inch = 1 foot

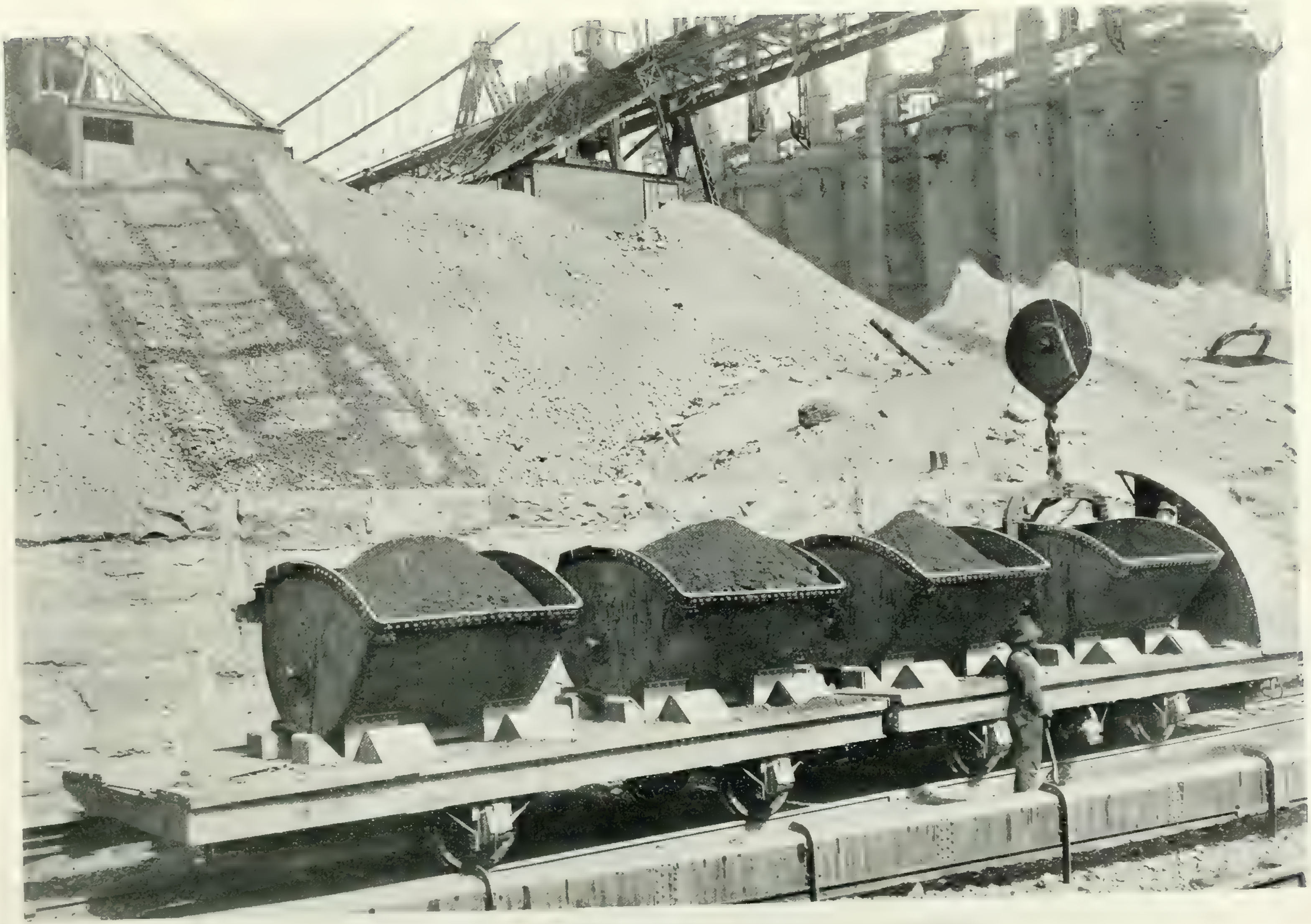
FIG. 1. SECTION OF ORE BUCKET.

FROM CAR TO STOCK PILE.

The hoisting, distributing and discharge of the bucket contents are effected by means of a Brown traveller or transporting crane, which we owe to the ingenuity of the engineers of the Brown Hoisting Company. For the distribution and stacking of minerals this type of crane possesses many advantages—especially where speed and enormous capacity are the most desirable requirements.

Of course, such a type of crane is only available for outdoor service, and when the principle of removing the ore outside the serious influences of wet weather has to be considered, this type of crane will of necessity have to give way to the ordinary traveller or other equivalent.

The central span of the Brown Hoisting Crane is 250 ft. long. One end is supported by a vertical built-up standard, the opposite end being supported by a sheer leg. The main horizontal girder is 62 ft. above the stock floor level. One girder cantilever, 160 ft. long, projects over the portion of the stockyard and over the



ELECTRIC BUCKET CARS FOR TRANSFERRING MINERALS IN THE STOCKYARD.

Showing Crane Attachment to one of the Buckets.

receiving portion of the bucket car siding. At the opposite end the girder projects 148 ft. The central girder part and the two projecting girders at each end make up an overall crane length of 550 ft., providing a sweep for hoisting and traversing effort equal to 540 ft. The traversing distance is of course only limited by the length of the pier tracks.

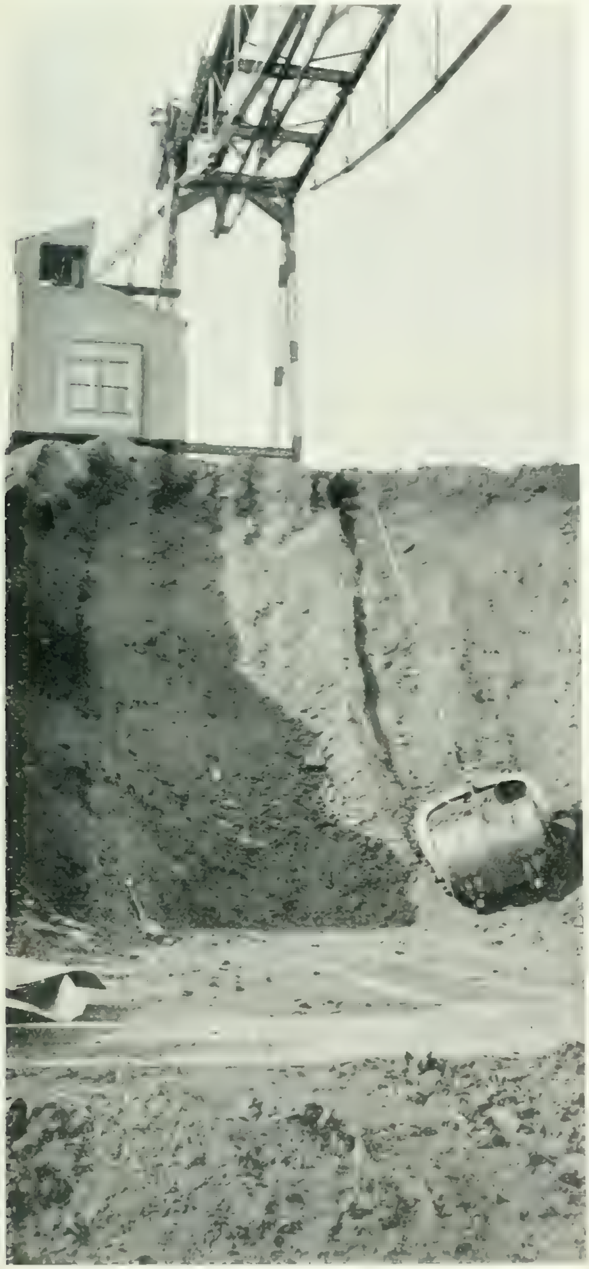


FIG. 2. SHOWS OPERATION OF FILLING ORE BUCKET.

The Brown Crane has its own engine-house equipment, located in such a position as will permit the greatest possible transverse movement of the buckets. The construction of the standards is clearly shown in the illustrations. The standards at their base have a width of 19 ft. 6 in., being reduced to 15 ft. at the top. The rail carriage supporting the standards is most strongly and solidly constructed. The sheer leg part of the crane is formed of two steel posts, separated at their base by some 20 ft., but joined above the stringer level of the crane. The two posts are strongly braced together, and rest solidly on their carriage, the latter being formed of two trucks as shown.

The Brown Crane is operated electrically, the potential of electrical power being made up of two 135 h.p. electric-motors installed in the crane engine house. The motions of propulsion, hoisting, and haulage are transmitted to the truck wheels of the carriage, carrying the crane supports, by means of suitable shafting and gearing. Suitable contrivances prevent the shafting from being subjected to excessive or abnormal torsional influences such as would be caused through changes in the position of the crane supports. For instance, the crane is centralised on the main standard support, and it can be made to turn through the distance necessary to prevent the disturbance or strain of the motion transmitting shafting.

The general construction of the crane is based on an inversed application of the bowstring principle of bridge construction, the bottom cords being parabolic and the upper ones straight. All the compression members are built up of mild steel channels, gas tubing being employed for the tensional members. In order to obtain the necessary metallic cross-sectional area for the main tensional members, with the minimum degree of wind-resistance area, these members are, wherever possible, made of plate steel with only their edges exposed to horizontal wind pressure effects. The subordinate tensional members, such as the diagonal ones, are made of the best wrought iron.

Hanging beams, extending the entire length of the crane, carry the traversing bogie or trolley throughout its entire course from end to

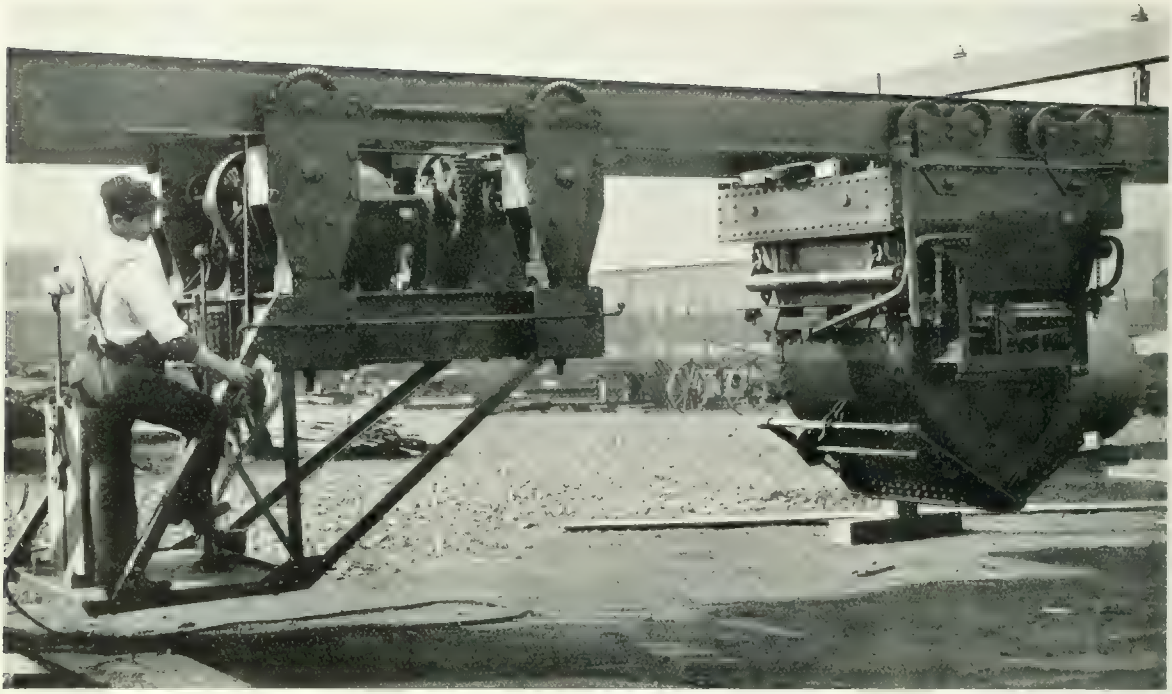


FIG. 3. STOCKYARD ELECTRIC-LOCO., WITH ITS MINERAL CAR SUSPENDED (WEIGHING TYPE) FOR TRANSFERRING THE ORE FROM THE STOCKYARD TO FURNACE ELEVATOR.

end, or 540 ft., the standards being so formed as to permit the unobstructed movement of the trolley and its suspended bucket. The trolley is hauled backwards and forwards by means of a steel rope, actuated by a winding engine located in the engine house.

The rapidity and effectiveness of the crane is such that a bucket of mineral, of a holding capacity of 9 to 10 tons, and having a tare weight of 13 tons, can be transferred from one point to another at a speed of 12 to 15 ft. per second, and lifted bodily at a speed of 4 to 5 ft. per second. The crane is easily capable of hoisting, transmitting and discharging thirty bucket loads, or 300 tons of minerals per hour.*

The object of the pointed spears projecting from the sides of the crane buckets is to reduce the amount of side scattering of the minerals when the bucket is overturned. By means of a simple trapeze gear, controlled from the crane engine house, it is possible to tip over or discharge the bucket at any point desired.

Of course, the ore can be transferred direct from the railway sidings to the well of the furnace hoist. It is usual, however, to provide an ample margin of stock, to satisfy all normal contingencies, as the working of a large capacity furnace from mine to furnace mouth without such margin is dangerous.

FROM STOCK HEAP TO FURNACE ELEVATOR.

We must now consider the arrangement for transferring the mineral on the stock heaps to the furnace elevator.

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* AERIAL AND LINK CHAIN TRANSPORT METHODS.—The author has noticed that in Germany aerial methods of transporting minerals are in regular use—in some instances the transmission distance is very considerable.

The actuation of the trolley can be effected either by mere steel rope haulage or by electricity. The system so far does not appear to have been applied for distributing the minerals longitudinally and transversely, but the author is satisfied that within a certain range of area at least both directions could be covered simultaneously.

The evolution of transportation by link chain methods has greatly progressed within the last few years, and [illegible] scheme of mineral transportation should fail to take [illegible] method into account, especially when [illegible] likely to produce physical disintegration. The link chain system, however, in any of its applications is likely to have a higher power absorption for a given weight transmitted than the aerial or Brown crane system.

Another type of transportation apparatus and one entirely of British origin is the Temperley transporter. This possesses many of the advantages of the Brown hoisting arrangement and has already been applied for mineral transportation purposes.

The bucket used for this purpose is peculiarly designed. It is really a neat combination of a shovel and a container. The *modus operandi* is as follows: the bucket, with its shovel mouth, is dragged over the sloping or inclined surface of the mineral pile and in its movement it is rapidly filled. (See fig. 2.) The entire operation is controlled from the engine-house. Automatic indicators show the operator when he may hoist, traverse, or overturn the bucket and apply suitable brake clutches.

The bins for receiving the minerals, etc. (inverted truncated cones in cross section), have double discharge doors—one delivering the mineral to the right and one to the left. The bin discharge doors are curved to a radius of a circle, and they revolve around a horizontal axis, although each door can be independently actuated. The bins discharge their contents into a suspended electric hauled car. (See fig. 3.) Each car has its own independent electric-loco., powerful enough to haul two cars—which are suspended from bogies running on girders, fixed and arranged in such a way that the discharge of the minerals is not intercepted. The car is equipped with weighing scales, so that the electric-loco. driver can charge his car with a predetermined mixture, made up from different bins.

This suspended electric-loco. stockyard mineral car train delivers the charge to the furnace elevator well, or at a location near to the furnace hoist. The same suspended and electric-loco. car, adapted to the coke bins, permits the coke to be hauled rapidly to the furnace elevator well, where it can be mixed with the materials making up the furnace burden.

DUQUESNE INSTALLATION.

The stockyard of the famous Duquesne Plant has ample space for the storage of 600,000 tons of ore. Its dimensions are: length, 1,085 ft.; width, 226 ft.

The stockyard is spanned by three Brown travelling cranes of the character described. During stocking season, Hopper bottom cars are discharged into bins arranged in two rows, one of which is allocated to supply the immediate demands of the furnaces; the other row, nearest stock accumulation, is used for transferring ore from the cars to the ore buckets. The latter, when filled, are picked up by the crane and automatically dumped on to the stock piles.

The removal of the ore from the stock piles is accomplished by the drag or bucket crane, as described. The holding capacity of the drag bucket is five tons. The drag buckets collect the ore from the face of the heap or pile, and then transport it either into the bins or bin-filling cars. The loaded cars are run over the bins allocated to receive their contents.

LORAIN COMPANY'S INSTALLATION.

In the Lorain Company's installation the stock bins are located underground. The stock bins are 725 ft. in length. The stock bin cars, electrically propelled with their own motor, are equipped with self-contained weighing hoppers, so that the carman can both transport and weigh. Five of these transport and weighing cars satisfy the requirements of two furnaces. The discharge door of the transport hopper is opened and closed by a direct and vertically operating pneumatic cylinder, the air being compressed by an electric-motor. The ore, limestone, and coke are transported, weighed, and delivered to the furnace skip car by the transport and weighing cars that draw their supply from the chutes in the bottom of the bins. The skip car then conveys the charges up the incline and delivers them at the furnace top.

FROM FLOOR TO PLATFORM OF FURNACE.

In the modern American practice the vertical lift elevator, whether direct lift winding, hydraulic or steam, has been displaced by the inclined rail track similar to that shown in fig. 4, or that of the illustration on page 282, showing the general elevation of a mineral elevating equipment and associated charging gear of a modern American furnace. By a very clever device the skip is made automatic or self-discharging, its contents passing direct into the well of the charging bell.*

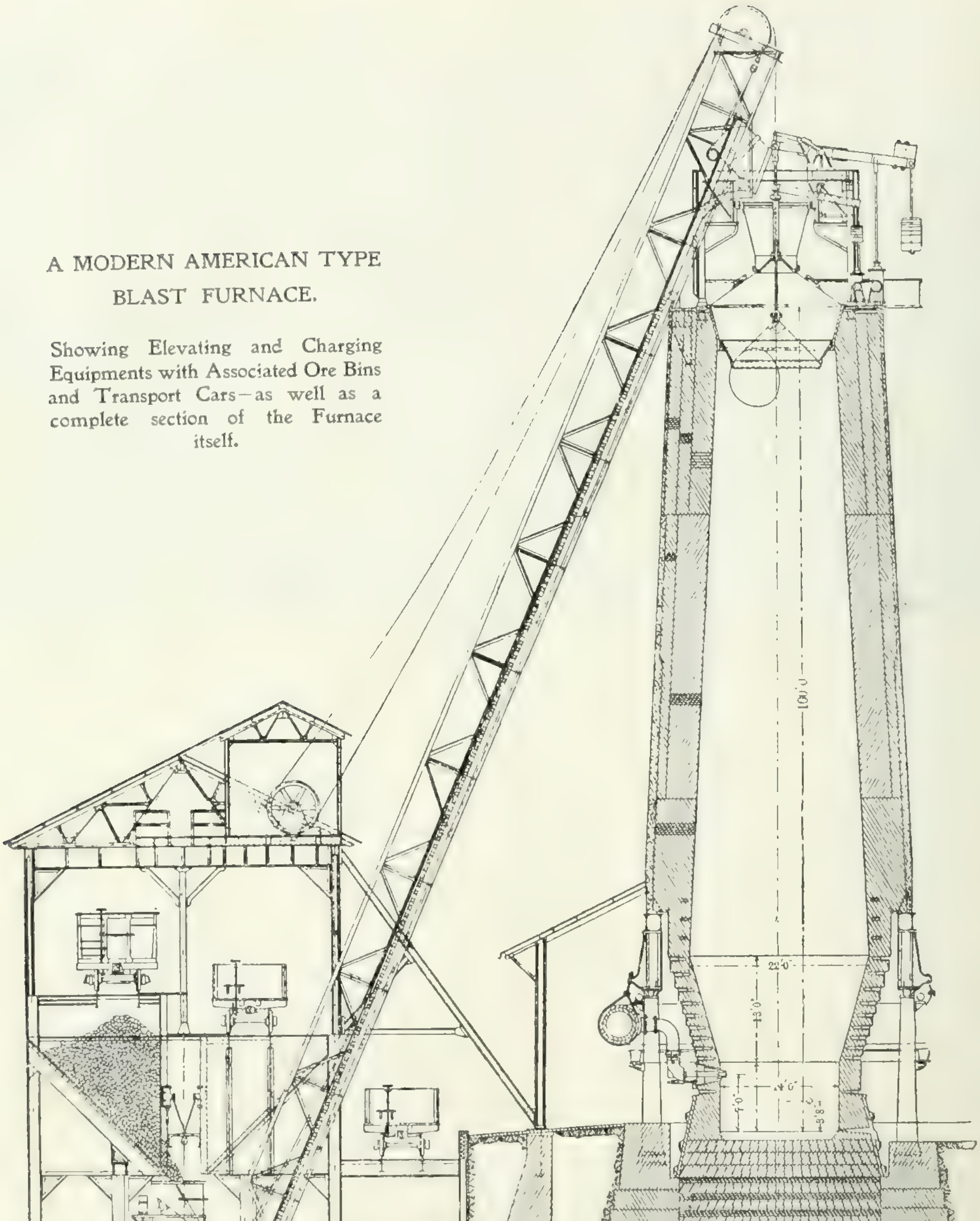
It will be noticed on referring to the figures that the gauges of the front and back wheels of the charging skip are different, the rear wheels

---

[illegible] tilting discharge is [illegible]

[illegible] steel cables—the [illegible] may be operated by [illegible] electrically.

In order to lessen the impact effect, when the skip reaches the tilting height, a spring buffer is provided for the rear wheels of the skip



A MODERN AMERICAN TYPE BLAST FURNACE.

Showing Elevating and Charging Equipments with Associated Ore Bins and Transport Cars—as well as a complete section of the Furnace itself.

having a wider rim surface than the front ones. The object of this dissimilar wheel rim width will be obvious. On referring to fig. 4, it will be seen that the arrangement permits a special or secondary track to be provided at the platform or top of the furnace on which the rear wheels can travel, and this track may be so devised as to elevate the back part of the charging skip when it reaches the top of the inclined track. The wider-rimmed rear wheels run over the special outer track, which raises them and the rear end of the skip into a tilting position such that its contents are deposited into the furnace charging bell.

The following are reference details of the hoist operating programme at one of the most recently-constructed American furnaces. Four hoisting trips are made for one lowering of the charging bell :—

Two hoisting trips of the skip elevate the coke.

Two hoisting trips of the skip elevate the ore and limestone.

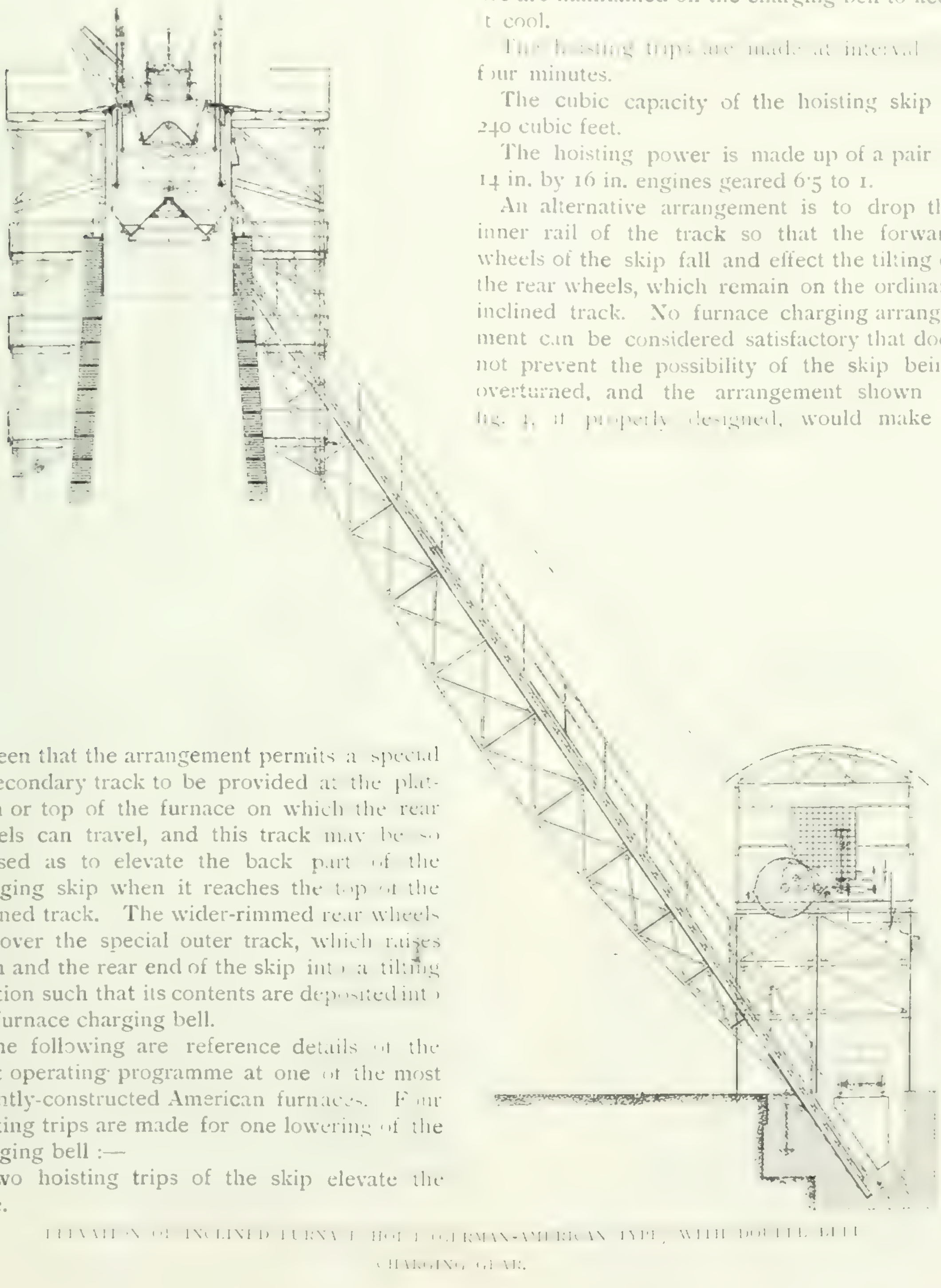
Two skip loads of coke or of limestone and ore are maintained on the charging bell to keep it cool.

The hoisting trips are made at intervals of four minutes.

The cubic capacity of the hoisting skip is 240 cubic feet.

The hoisting power is made up of a pair of 14 in. by 16 in. engines geared 6·5 to 1.

An alternative arrangement is to drop the inner rail of the track so that the forward wheels of the skip fall and effect the tilting of the rear wheels, which remain on the ordinary inclined track. No furnace charging arrangement can be considered satisfactory that does not prevent the possibility of the skip being overturned, and the arrangement shown in fig. 4, if properly designed, would make it



ELEVATION OF INCLINED FURNACE HOIST (GERMAN-AMERICAN TYPE), WITH DOUBLE BELL CHARGING GEAR.

impossible for the skip to be drawn into the well of the charging bell.

THE UNIFORM CHARGING OF THE MINERALS INTO THE FURNACE.

There are several arrangements in use, designed to secure in a less or greater degree, the uniform distribution of the materials around the main charging bell, so that when the latter is lowered the materials fall in equal proportions all round and from the bell rim, and the burden of the furnace is maintained at a uniform depth.

One arrangement, directly and centrally superposed over the main charging bell, provides a secondary and much smaller charging bell whose well is of sufficient capacity to receive the contents of a specific number of skips. When these skips have been discharged, the smaller bell is lowered, depositing the minerals, etc., more or less uniformly all round the main charging bell. When the main bell is lowered the superposed bell is maintained closed, so that the gas cannot in a serious degree escape from the furnace.* In modern German practice, the charging of the mineral into the superposed bell is also proposed to be effected in such a way as to secure uniform distribution of the mineral on to the secondary bell—this arrangement is shown on page 283. It will be noticed that the charging skip is also equipped with a discharge bell.

Fig. 5 shows another arrangement, in use in American furnaces, having for its object the uniform distribution of the minerals into the furnace. Instead of the secondary superposed charging bell, a mineral receptacle into which the skips deposit their burden is made to revolve horizontally by means of pinion and circular rack gearing, set in motion as the skip descends; each mineral discharge of the skip into the receptacle is by this rotation uniformly deposited on to the bell and all round it. When the well of the main bell has received its full complement of minerals, the bell is lowered, but the gas is prevented from escaping by the rotation of the receptacle which closes off ingress connection to the main charging bell.

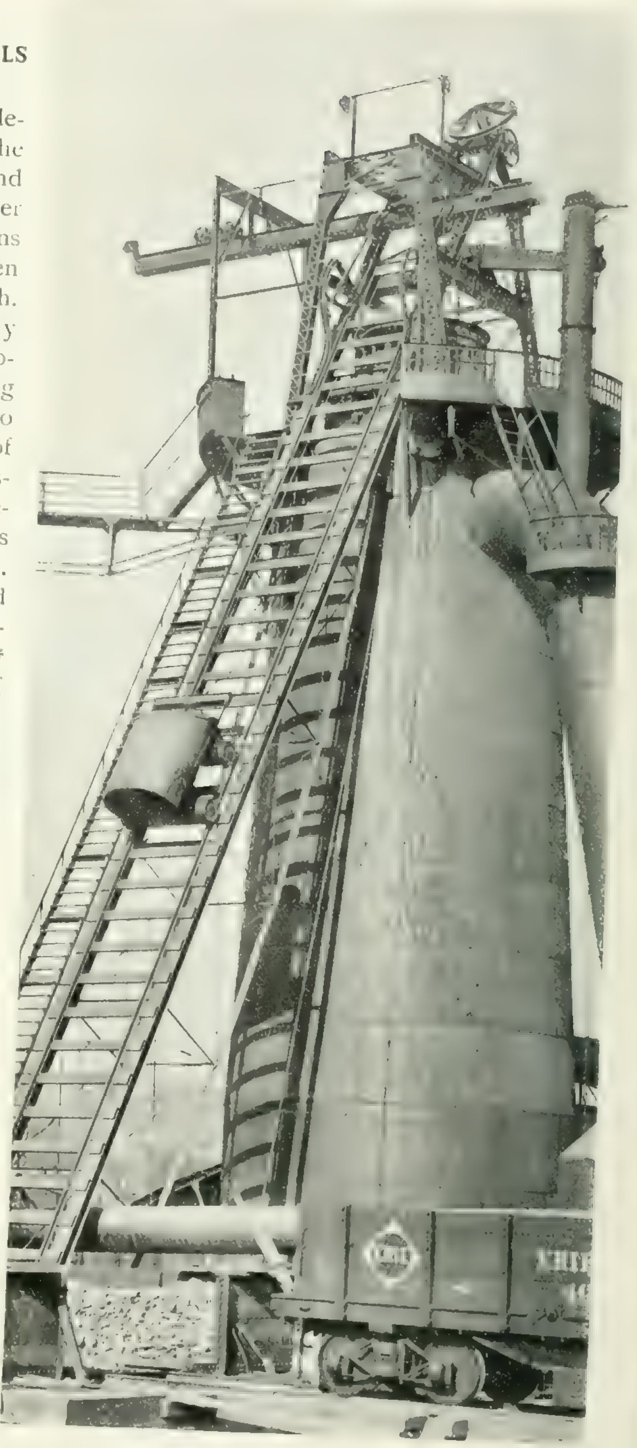


FIG. 4. AMERICAN TYPE OF ELEVATOR AND TOP GEAR WITH ROTATING MINERAL DISTRIBUTOR.

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* The upper [illegible] hopper is equipped with [illegible] removed [illegible] so that [illegible] equipped with [illegible]

The prevention of the escape of the gas during charging operations is very desirable, because combustible gas means power, and power means money. Many British furnaces, even now, have actually no charging bell at all, and a great part of the valuable power-gas is thus lost; when such furnaces are closed in, the lowering of the bell means the escape of a considerable volume of gas. The author has designed a secondary and balanced cover arrangement to prevent such a gas escape. (See fig. 6.) The application of the contrivance does not interfere with the existing arrangements of charging.

The direct elevating arrangement shown in fig. 7, designed by Mr. Healey, is an enlarged adaptation of the ordinary bucket chain elevator, and is, therefore, continuous in action.

It possesses the following features: Its continuity of action enables the tare weight of the buckets to be more or less exactly counterbalanced. There is no possibility of overwinding. The energy absorbed in overcoming the inertia of the buckets is reduced to a minimum. The arrangement for the distribution of

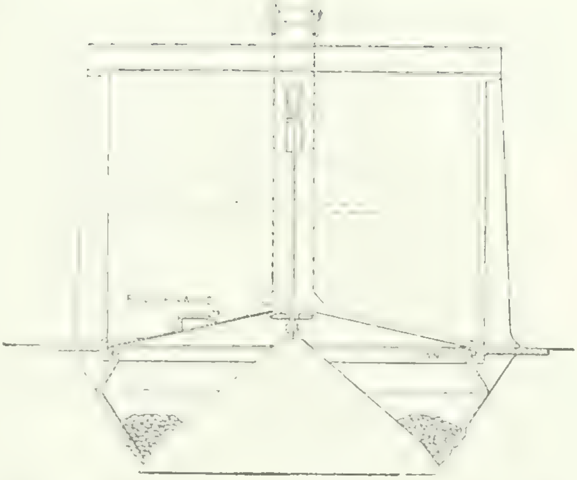


FIG. 6. ARRANGEMENT FOR PREVENTING THE ESCAPE OF FURNACE GAS DURING CHARGING OPERATION, FOR FURNACES EQUIPPED WITH AN ORDINARY BELL USUAL IN BRITISH PRACTICE.

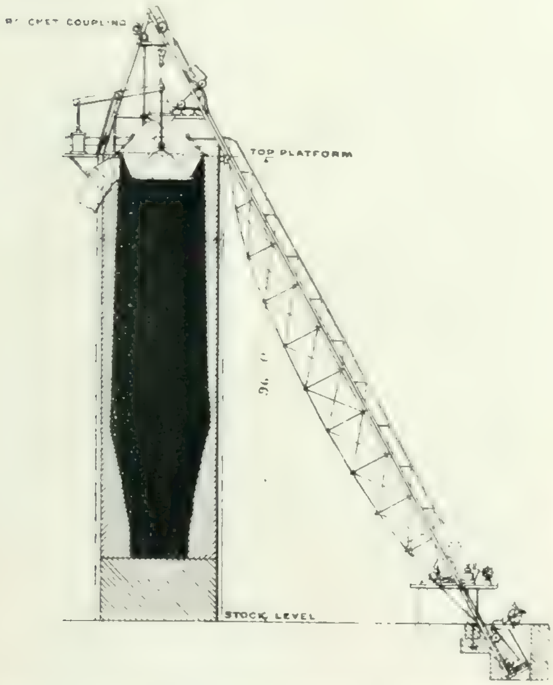


FIG. 5. AMERICAN TYPE OF FURNACE ELEVATOR, WITH ROTATING MINERAL DISTRIBUTOR.

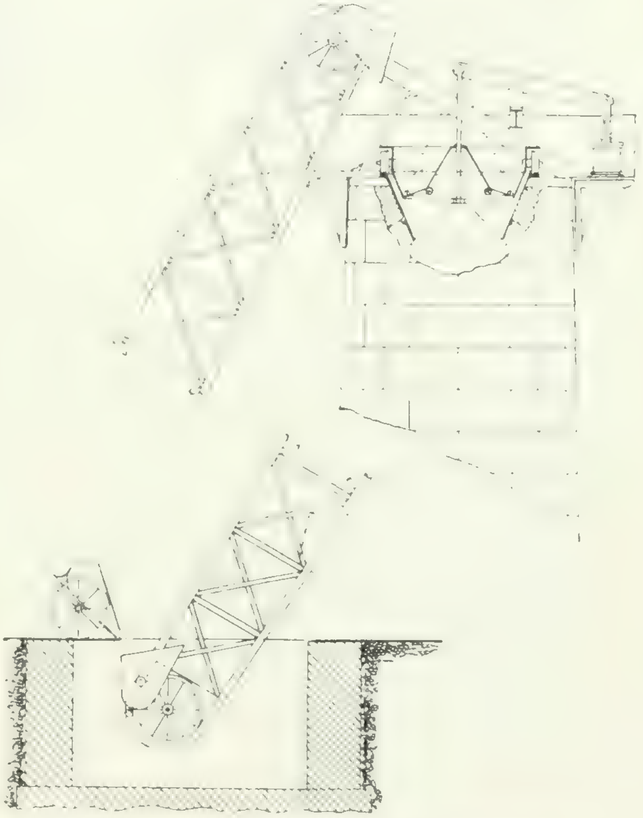
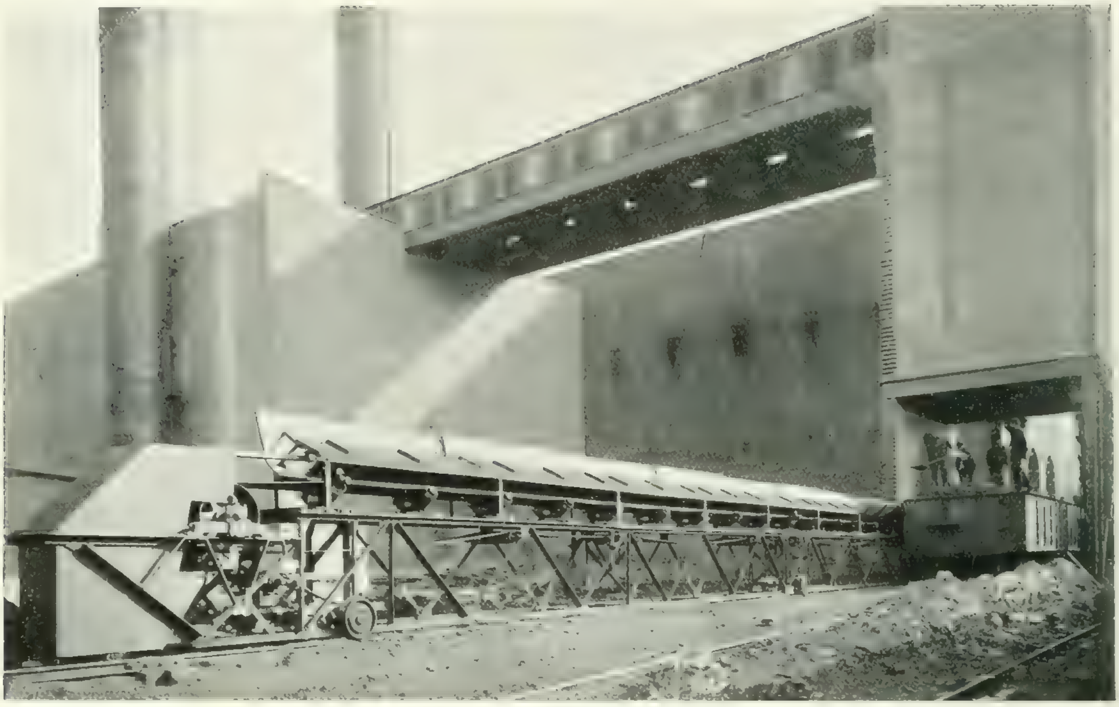


FIG. 7. TYPE OF BUCKET ELEVATOR, WITH ARRANGEMENT FOR DISTRIBUTING THE MINERAL INTO THE FURNACE.



TRANSPORT OF MINERAL ORES ON THE ROBINS' SYSTEM.

Showing the method of transferring the ore from the car to the conveyor

the charging of the load into the furnace is shown in fig. 7.

Over the main charging bell there is an ore-distributing receptacle mounted on flanged wheels. The receptacle is divided into six compartments, each having its own discharge or bottom door. This receptacle rotates on the wheels on which it is mounted, in such a way that when the skip reaches the top of the elevator incline and is ready to discharge its contents, one of the six compartments is always ready to receive them. The rotation of the receptacle synchronises with the intervals, ascent and discharge of the different skips, the movement of which, ascending and descending, effects the rotation of the distributing receptacle. The opening of the discharge doors of the receptacle permits the mineral to fall on to the main charging bell, but when the latter is lowered the discharge doors are closed, thus preventing the escape of the gas during the operation. The elevation of the bucket should automatically register its ascent and the fact that it is loaded.

The development of the ordinary chain elevator type in recent years has been extremely great, and in that of the Robins' type particularly. This exceedingly efficient method of transportation is in common use for transporting ores. An example of its application to the transport of iron ores is shown in the accompanying illustration. In the frontispiece will be found an illustration of the Robins' Conveyor, showing the transfer of the mineral over an incline having a very considerable gradient.

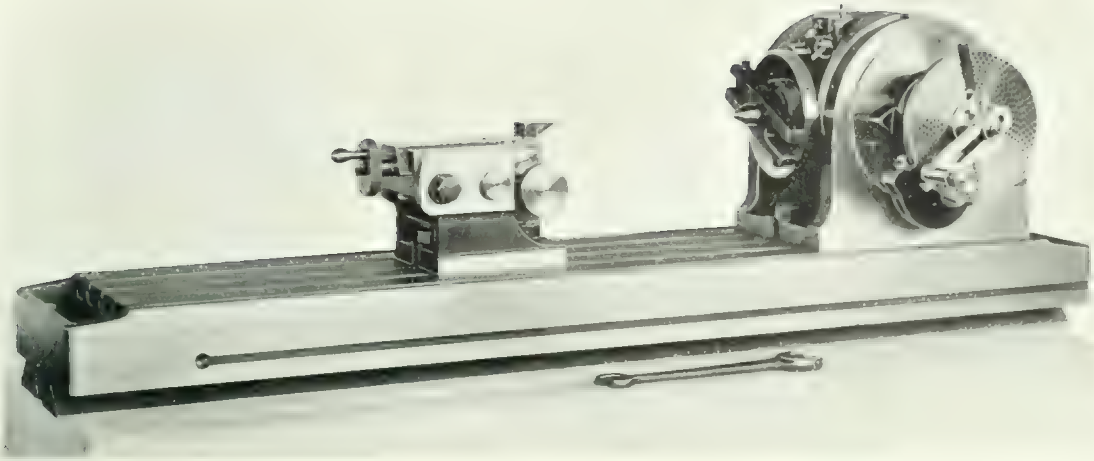


FIG. 2. NEW DIVIDING HEAD AND TAILSTOCK FOR CINCINNATI UNIVERSAL MILLING MACHINES

MILLING MACHINES.

BY

JOSEPH HORNER.

Deals with the Universal Index and Dividing Head. [illegible]

III.

A GOOD idea can be gathered of the general construction of milling machines from photo illustrations. But there are certain details which cannot be understood or explained clearly without detailed drawings. Chief among these is the Universal Indexing and Dividing Head, which is one of the most remarkable elements in machine tool design, by reason of the very high degree of precision embodied in it. The same remark applies to feeds, to be considered in another article.

A machine is rendered universal by the fitting of a spiral head and index plate, in conjunction with a swivelling table and change gears. The index plate gives divisions of a circle, and change gears impart the spiral movement while the table is being traversed by the feed screw. Though there are similarities in external appearance in most dividing heads, yet there is a good deal of difference in detail and in workmanship. We cannot do better under these circumstances than illustrate one of the best and latest types with sectional views, that of the Cincinnati Milling Machine Company, of Cincinnati, Ohio.

THE CINCINNATI UNIVERSAL HEAD.

The general appearance of the machine itself as now made by the firm, is seen in fig. 1, the head and back centre, are shown in the photo fig. 2, while the detail drawings of the head are given in figs. 3, 4, 5. Fig. 3 illustrates the head and tailstock in external elevation, and figs. 4 and 5 are sections of the former in the longitudinal and transverse directions respectively.

Distinctive features of this design are the following :—

The swivelling block, A, which carries the spindle, B, makes a complete revolution in the

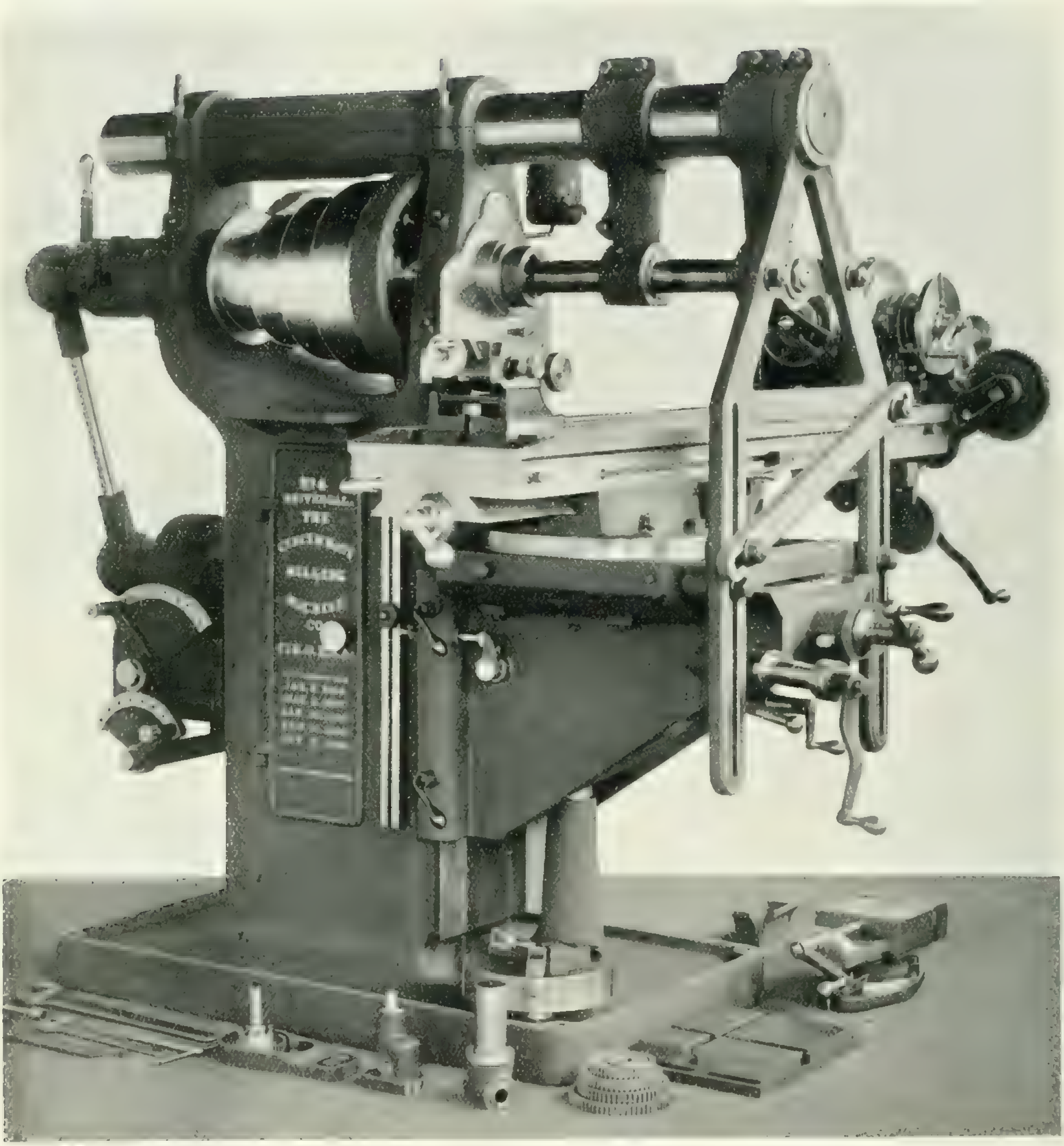


FIG. 1. THE LATEST PATTERN CINCINNATI UNIVERSAL MILLING MACHINE. THE CINCINNATI MILLING MACHINE CO., CINCINNATI.

vertical direction. This it has in common with some other modern heads, but in general the movements of heads are confined to angles ranging from 10 deg. below the horizontal and 10 deg. beyond the perpendicular. And when cutting spirals the movement is still large, ranging between 5 deg. below the horizontal to 50 deg. beyond the perpendicular. The capacity for complete revolution is in some cases an advantage, because it permits of the cutting of right- and left-hand work without changing the cutter, and the cutting of the same piece of work on either side of the perpendicular. Moreover, the swivelling block is contained wholly within its bearings at whatever angle it may be set. By means of a new clamping arrangement it is held securely in any position without strain being thrown on the spindle. This comprises two trunnion bearings on the swivelling block, embraced by the clamping rings, C, pinched by two cap screws, D, the action being similar to that of clamping a shaft tightly in its bearings. In this case the circumference of the trunnion is very large, with the result that no disturbing influence can possibly affect the spindle or the worm gear. The edge of the swivelling block is of course graduated into degrees.

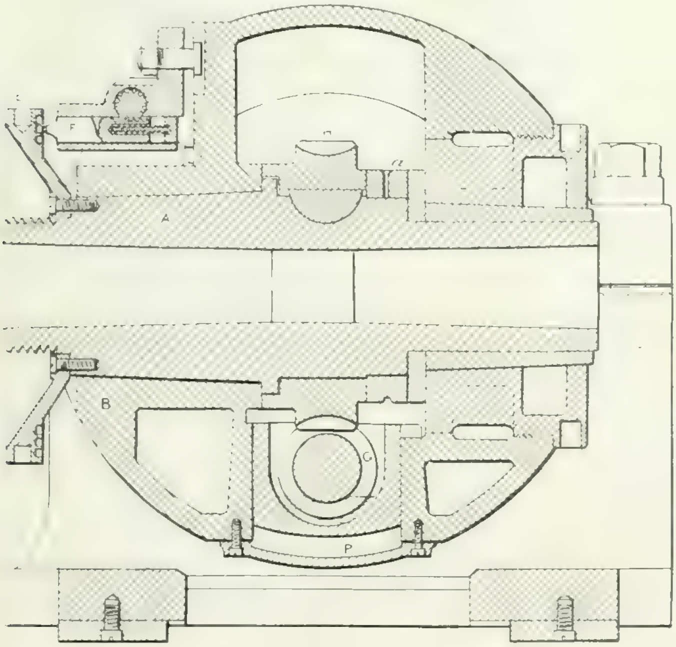


FIG. 4.

The spindle, A, is provided with a clamp ring at *a*, which secures it endwise, and does not disturb its accuracy. The coned bearing neck at the front and the coned bushing at the back afford provision for taking up wear. The hollow spindle has a tapered hole in front.

THE DIVIDING MECHANISMS.

These include the worm and wheel, and a special and very convenient index plate, E. The latter is used for getting low numbers in order to avoid the risk of mistakes that sometimes occur in counting the number of turns of the worm for low numbers. Divisions under 40 are obtained with this plate. On all divisions of 40 and over, more than one turn of the worm is not required.

The plate, E, for direct indexing, is dish-shaped, and has three circles of holes, 24, 30, and 36 on the back, in a position where they are protected from dirt and chips. This, with the adjustable pin, F, is seen in sectional detail in fig. 4. The pin holes for 4 and 6 divisions, which are so frequently required for fluting, nut-making, etc., have their positions indicated on the edge by figs. 4 and 6, so saving the trouble of counting the holes. This plate has a further and subsidiary utility, since when it lies in a position approaching to the vertical it affords protection to the cutting head from falling chips and oil.

DISCONNECTION OF WORM AND WHEEL AND THEIR ADJUSTMENTS.

The worm, G, and its wheel, H, are seen in gear with each other in the drawings. To effect their disconnection the worm is dropped bodily in its bearing or case, J. This, it must be noted, is a vertical movement only, and not an eccentric one. It is effected by the eccentric pin, K, that moves the case bodily up or down. As the latter is confined sideways, the eccentric end of the pin is inserted in a bushing, L, which has endlong motion in the worm case, and so produces the motion.

The screws, M, tie the worm case to the block above, which is drilled

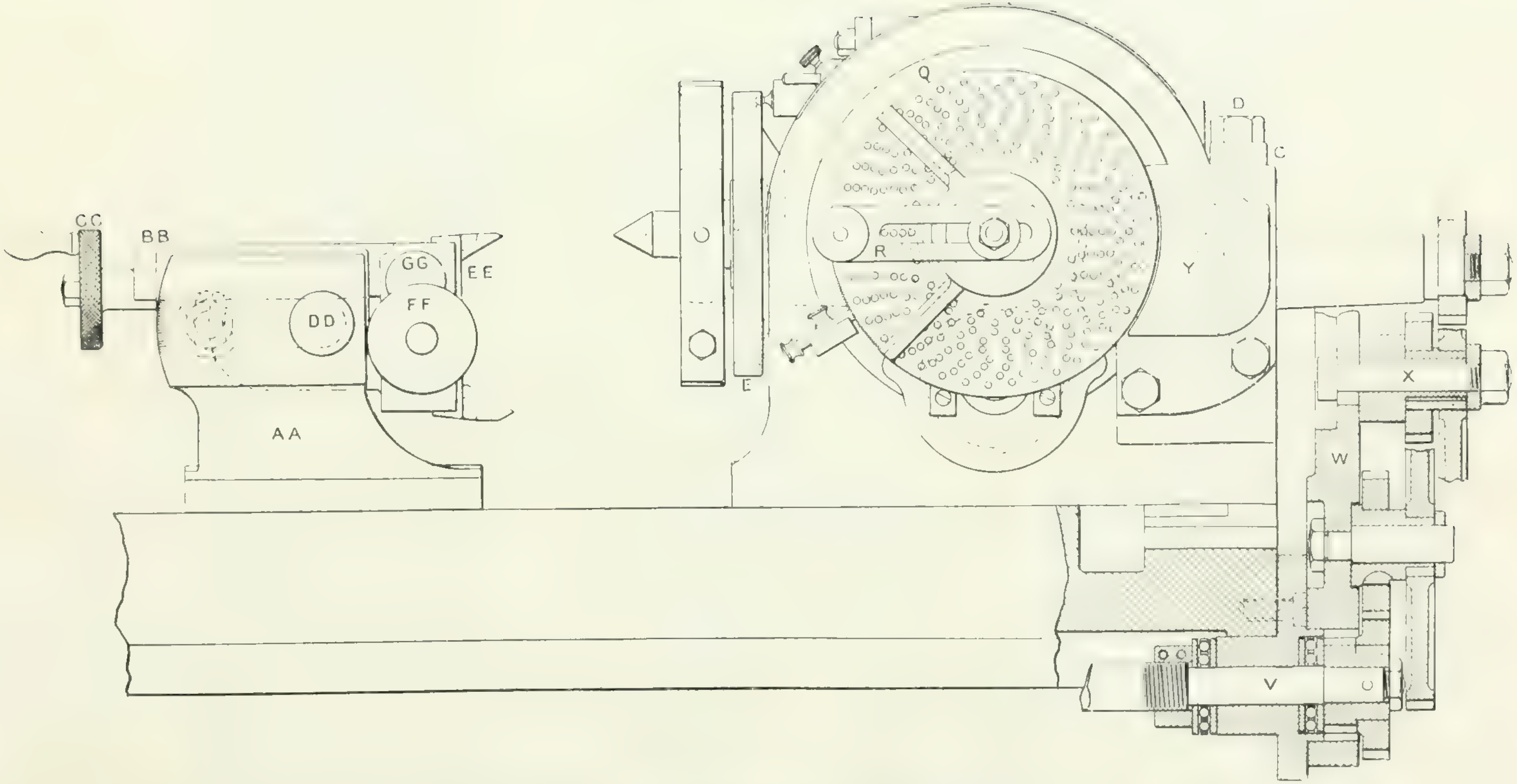


FIG. 3. HEAD AND TAILSTOCK IN EXTERNAL ELEVATION.

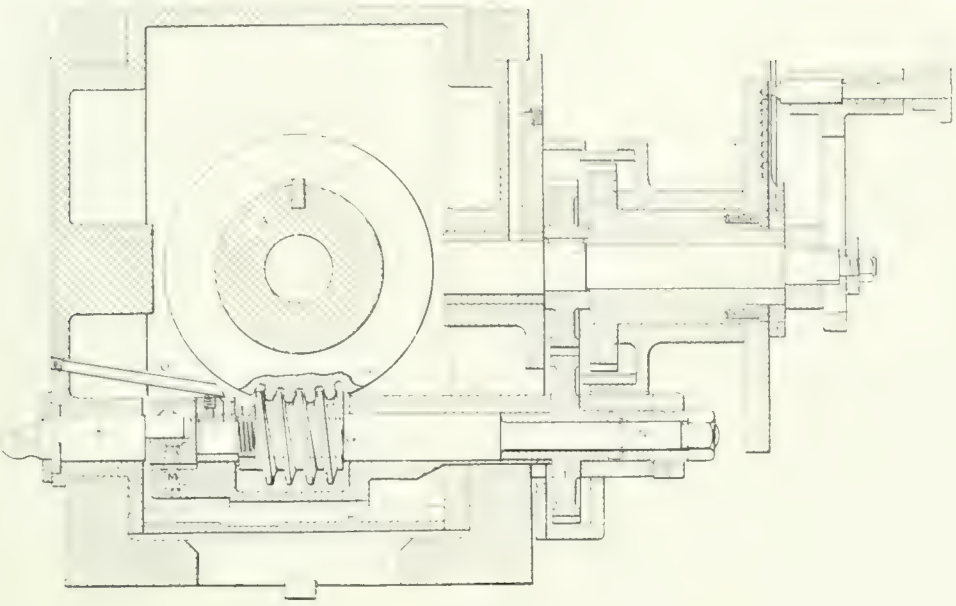


FIG. 5

for L, and by means of these screws the worm is adjusted to the wheel. This is a straight line movement, as it should be. At the other end the worm case swivels about the pin, N, as a centre.

There are thus two separate adjustments provided, and each in a straight line, that for taking up wear by the screws M, and that for engagement and disengagement by the lever, K, and sliding pin, L, both of which are ideal arrangements, theoretically correct.

The worm is single-threaded, and right-handed, with two and a half threads per inch. It runs in a bath of oil supplied through the tube, O. The cap, P, can be removed for purposes of cleaning and examination. The wheel has the usual forty teeth, so that forty turns of the handle, R, move it through one revolution. Both it and the index plate are of good size.

THE INDEX PLATE.

The index plate, Q, is drilled from both sides, so that when reversed it provides a large number of divisions without having to use extra plates. Extra special plates are however provided for effecting divisions that cannot be obtained directly from the standard plate which is furnished with a machine—the principle being the addition or subtraction of fractions—adding or subtracting two indexings. Such divisions have hitherto been obtained by the tedious method of compound indexing. The work is rather puzzling to the uninitiated, and a description of it would encroach too much upon the space at our disposal.

The dividing or indexing head is used on plain milling machines as on universals, but the change gears for spiral work only upon the latter. The illustrations, figs. 3 and 5, render this distinction clear. In fig. 5 the revolution of the handle or index pointer, R, turns the worm and its wheel through equal gears, S, T. When spirals are being cut the worm is driven through the gear, U.

THE CHANGE GEARS.

The connecting up of change wheels from the lead screw, V, is illustrated in fig. 3, W being the swing plate, and X one of the two studs for compounding trains. The motion is transmitted to the spindle at right angles by the bevel wheels, V, actuating the spur wheels shown in fig. 5. The dotted lines of these bevel wheels are seen in fig. 3, in which details may be noted, by the way, of the ball thrusts to the lead screw, Woodruff keys to the worm wheel, and some of the fixed gears ; also a fine adjustment of the index plate by ratchet and pin for resetting work. But we must now give some attention to the methods of operating this piece of mechanism.

THE METHOD OF INDEXING, AND OF CUTTING SPIRALS.

We start with the fact that the arrangement of gears permits the spindle to be rotated automatically at whatever angle it may be placed, that the index plate gives equal divisions, and that the change gears impart a rotary motion to the spindle, the amount of which bears a relation to the pitch of the lead screw. As the worm thread and the worm teeth are as one to 40, forty revolutions of the wheel to one of the worm form the basis of calculation. The value of the index plate used in conjunction with this lies in making sub-divisions when the crank or pointer has to make less than a complete revolution to effect the required division. Thus, forty turns of the crank effect one revolution of the main spindle, and one turn would effect a fortieth of a revolution of the main spindle, and therefore this operation would have to be repeated forty times to obtain forty divisions to the circle. To obtain eighty divisions the crank would be turned but half way round for each division; to obtain twenty, two turns would be required. Hence the rule—divide 40 by the number of divisions required, and the quotient will be the number of turns or parts of a turn which will have to be imparted to the crank. Thus—

$$\frac{40}{40} = 1 \qquad \frac{40}{80} \quad .5 \qquad \frac{40}{20} \quad 2$$

Or, taking a number, say 144, then $\frac{40}{144}$ may be reduced to $\frac{5}{18}$, which means that the crank must be moved $\frac{5}{18}$ of a turn.

THE SECTOR.

In getting into these fractional parts it is necessary to select circles of holes which are either of the number required, as 18 in this instance, or a multiple of the same, as 36, 54, 72, etc. Here the value of the sector comes in,

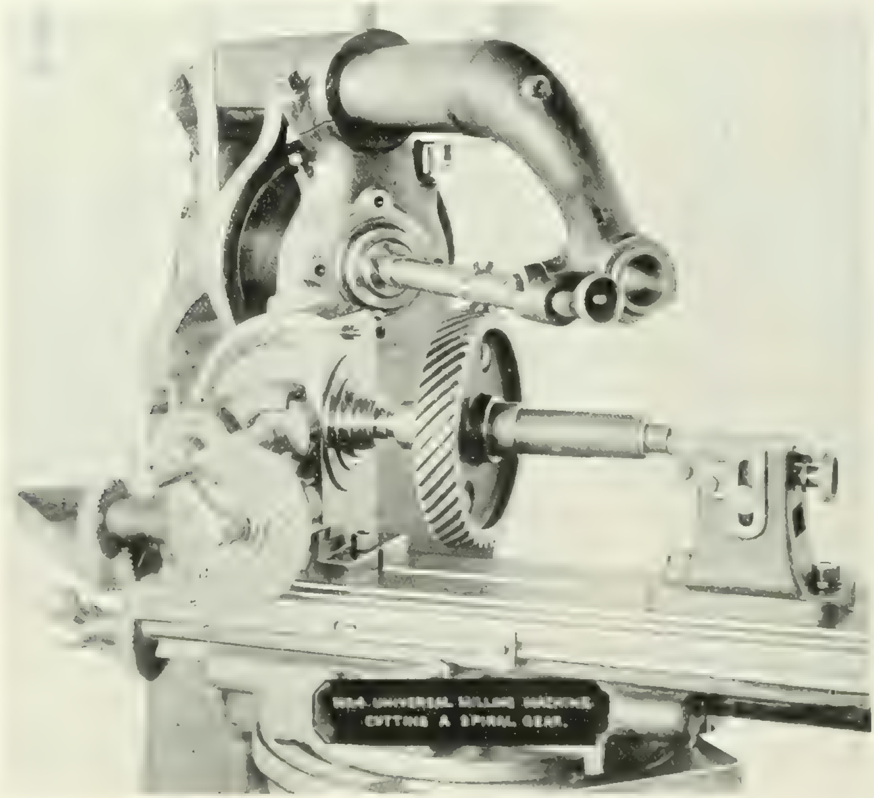


FIG. 6. CUTTING A SPIRAL GEAR ON A BROWN AND SHARPE UNIVERSAL.

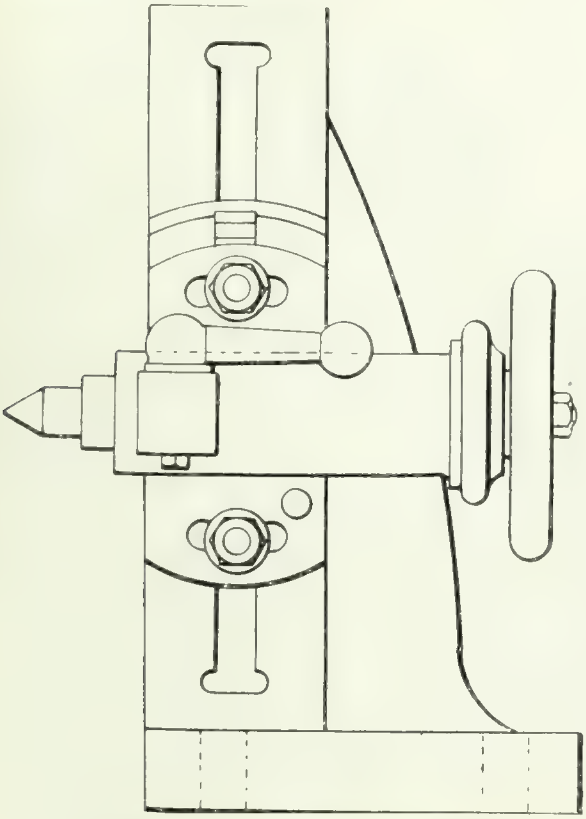


FIG. 7. TYPE OF TAILSTOCK IN USE ON THE CONTINENT.

because the counting of holes is liable to error. Having a sector once set to, say, every fifth hole in the 18 hole circle, or tenth hole in a 36 hole circle, further risk and trouble are saved. The sector is seen in figs. 2 and 3. It is set to one hole more than the spaces to be counted, and there clamped. That is, the hole in which the index pin enters is not counted, but the 5, or 10 holes, or other numbers as may be required are counted apart from this one. When the sector is tightened with its screw, no further counting is necessary, but it is simply moved against the index pointer for each division. When this has been repeated the proper number of times, and a cut made at every setting, the main spindle in the dividing head will have made one revolution.

To facilitate this work, and save the labour and risk of calculation, is the reason why index tables are furnished, which give opposite the number of divisions required the number of holes in the index plate which may or should be selected, and the number of turns of the crank required for the circle of holes given. These tables may, of course, be used merely as a basis to work upon, other circles and numbers of turns being easily deduced therefrom.

METHODS OF CALCULATION.

The dividing head used alone finds its applications in fluting taps and reamers, in cutting wheel teeth and ratchet teeth, etc. But for spiral teeth, and for twist drills and spiral milling cutters, the spindle must be rotated by the change gears. These are exactly the same as for screw-cutting in lathes, but the subject is approached from a rather different standpoint. Thus, instead of taking the pitch of the screw or spiral as the basis, the distance through which the table travels during one revolution of the spindle in the dividing head is given, and this is termed the lead of the spiral. If the spindle makes one turn to 6 in. travel of the table, the lead is 6 in.; if one turn in 10 in., this is a lead of 10 in. The calculations involved are simple, because the lead screw usually has four threads per inch, and forty revolutions of the worm are required to impart one revolution to the spindle of the dividing head. If gears of equal diameter were put on the lead screw and on the worm shaft, the lead screw would therefore have to be revolved forty times to rotate the worm shaft forty times, and in that period the table would travel 40, divided by its pitch 10 in. Other gears are obtained by multiplying the required lead in inches by 4.

Having obtained the ratio in the form of a fraction, the latter is divided into two, as in screw cutting, and the numerator and denominator of these fractions are multiplied by a number to give numbers of teeth of wheels in the set available. This applies to compound gears. In a simple train two wheels give the ratio, one going on the worm shaft, the other on the lead screw, with an intermediate, which, of course, may be of any size, to connect them.

The setting of the table to the angle of the spiral to be cut is obtained either graphically or by the aid of tables. In the first case, the hypotenuse of a triangle is taken, one side of which equals the lead, the other the circumference of the spiral. In the second case, the circumference is divided by the lead, and the quotient compared with a table of natural tangents, and the table set to the degrees obtained. Or a table is consulted which gives a wide range of angles for different spirals.

Fig. 6 illustrates the cutting of a spiral gear on one of the Brown and Sharpe universals. In this head the spindle is rotated in a curved seating in which it is clamped. The spindle can be rotated independently by the worm and wheel, since the worm can be thrown out of gear with the wheel by an eccentric bushing. The spindle may then be turned by hand and locked by the index plate and pin. In the head for the No. 1 or smallest machine, steel bushings afford a bearing for the worm shaft, and a pivot for the spindle box, and the front end of the latter is set by suitable graduations to any angle from 5 deg. below the horizontal to the perpendicular. In these heads the worm wheel has forty teeth, and the worm is a single-threaded one.

A special spiral head by the Cincinnati Milling Machine Co. is designed for cutting coarse spirals, for which it is better adapted than the regular head. The worm is double threaded, and of $1\frac{1}{2}$ in. pitch, and the wheel is $8\frac{3}{4}$ in. in diameter.

PLAIN INDEXING CENTRES.

These are used on both plain and universal machines. Division is effected by plates and index peg. Two plates are fitted in the Cincinnati, one for getting all odd divisions up to 50, the other all even divisions up to 100. The spindle is hollow, with a standard taper at the front end. The nose is threaded and covered when the chuck is not in use. To relieve the index pin and plate from strain, the spindle is clamped firmly in position during cutting. To extend the range of service, raising blocks are fitted for increasing the height of centres.

THE FOOTSTOCK.

When work has to be carried at each end, as in fluting taps, reamers, drills, cutters, etc., the tailstock or footstock is used in conjunction with the dividing head. This is seen in figs. 1, 2, 3, and 6. That of the Cincinnati Company is seen in some detail in fig. 3. The housing, AA, carries the longitudinal slide, BB, which fits into it with a dovetail, being traversed by the knob, CC, and clamped by the bolt, DD. The centre bar, EE, is double-ended, one end having an ordinary centre for heavy work, the other being reduced on the top face to enable cutters to clear when fluting, which frequently approaches very near the centre of the work. The position of the bar is readily reversed. It is adjustable vertically with rack and pinion, actuated by the knob, FF, and clamped by the bolt, GG. The centres can also be tilted forwards, swivelling about the centre, DD, graduations on the housing giving exact angles. The Brown and Sharpe footstock is made on another pattern. Two taper pins are used to adjust the centre in line with the headstock centre. To set it at an angle, a rack and pinion are used. The centre is clamped firmly by three nuts.

A different type of tailstock, fig. 7, is common on the Continent. It comprises an upright on which a swivelling block that carries the centre is adjustable vertically, a screw being frequently used for convenience of moving the block. The latter is made to swivel for the purpose of

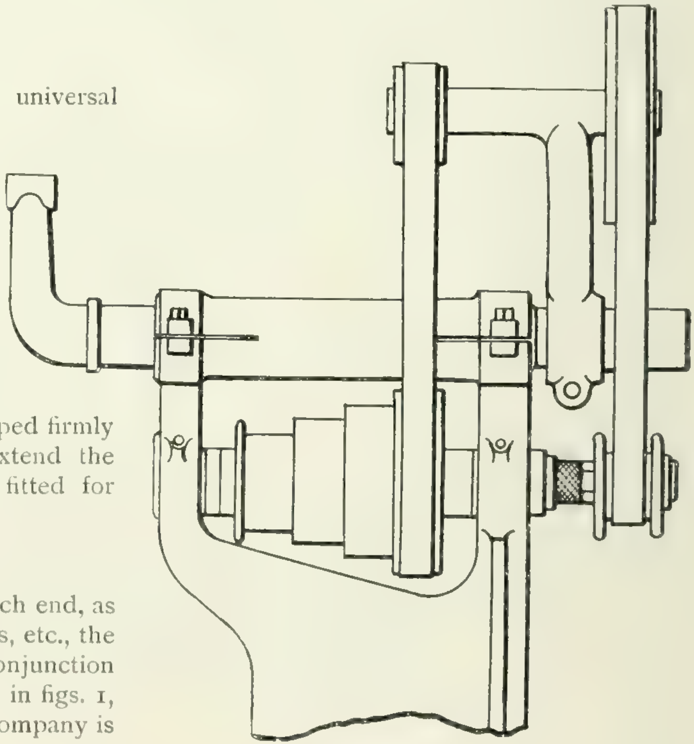


FIG. 8. HIGH-SPEED FITTINGS.

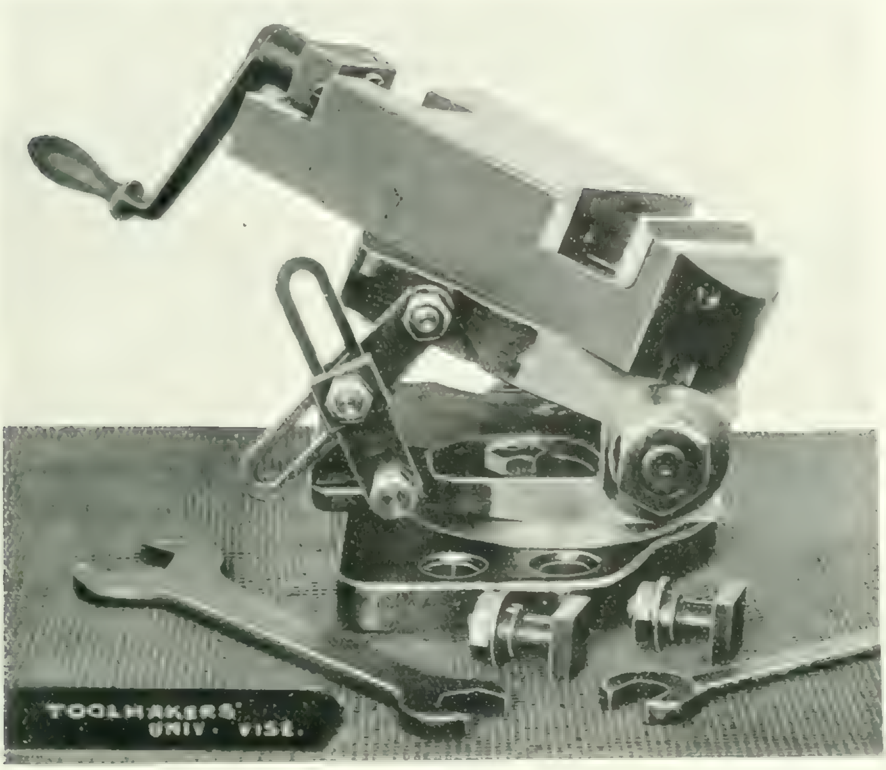


FIG. 9. TOOLMAKERS' UNIVERSAL VISE FOR BROWN AND SHARPE MILLING MACHINES.

supporting the outer end of taper work, when the taper is long, and the angle large. It provides the same movements as the American and English patterns, but a screw is used instead of a rack for the vertical movement, and the mechanism is entirely different.

OTHER FITTINGS.

There are numerous other attachments made to plain and universal machines with the object of increasing their range of service. They generally comprise a high speed fitting, and a rack cutting attachment and vises. Frequently also a table for rotary milling, a cam cutting device, a vertical spindle, and a universal attachment.

The high speed fitting, fig. 8, is used for light end mills chiefly. It comprises a spindle which runs in a shell that fits the taper hole in the main spindle. It is driven by a belt from above, which is operated by a belt and pulley driven from the headstock main cones. The pulleys have their bearings in a bracket, which is clamped on the overhanging arm standing above it, or some equivalent device. Speeds of over 1,500 revolutions per minute are thus obtainable.

In a rack cutting attachment a pair of bevel gears changes direction of motion from the spindle to the rack cutting spindle and arbor running parallel with the table. The advantage of changing the axis is that there is no limit then to the length of rack it is possible to cut. The racks are held in a specially long vise. By fitting a slitting cutter, stock can be sawn off by the same attachment.

A circular milling attachment is often very valuable for conveniently doing work that would otherwise go to the lathe.

Rectangular vises are made in various designs to bolt to the machine tables to hold work parallel with or at right angles to the table, to swivel to horizontal angles or to vertical angles, and having graduated edges. One of these, by Brown and Sharpe, is shown in fig. 9.

(To be continued.)

EXAMINATION OF PATENT SPECIFICATIONS.

BY

JAMES SWINBURNE,

President of the Institution of Electrical Engineers, Member of the Institutions of Civil and Mechanical Engineers.

ARGUMENT. Examination with guarantee by State. Examination as to novelty without guarantee. Popular ideas as to simplicity of examination. Inventions, matters of degree. Differences small on paper determine great commercial advantages. Danger of undeserved monopolies when the State guarantees. Danger of ill-advised rejection. Impossibility of settling novelty at date of application in certain cases. Present fees not paid as price of monopoly, but to cover office expenses, and to go to the Treasury as tax on industry. German and American practice.

THERE are a great many incompatible theories as to what the Government ought to do for patentees. Some people hold that it is the duty of the Government, or rather of the State, by means of its patent office and its officials, to examine an applicant's specification thoroughly and completely, and if it covers a good invention, to protect the patentee from all infringement; all examination and subsequent legal proceedings being borne, as to expense, by the State, that is to say by the public. Others, who do not go quite so far as this, hold that the patent fees paid by the inventor should cover the cost of examination, but the cost of the proceedings against any infringer should be borne by the State. Another idea is that the fees should be in excess of the office expenses, the balance of all the fees being pooled as a fund to defray expenses of prosecuting infringers. The other extreme of view is that the patent office should not examine at all, but should grant an apparent monopoly to anyone who asks for it, or what is much more important, who pays the fee for it.

For typical examples we may take as one extreme Germany, where there is a very thorough examination, and the State protects the patentee. England, where they charge fees in excess of the expenses, and make a small but useful examination on some points, is almost extreme in the other direction. The present examination in England is rather peculiar; it has eventually developed into an examination as to the form of the specification, and it is really a great benefit to inventors. There is a Bill to alter the examination now before the House of Commons. This will be mentioned later. The United States stand between, as they make a thorough search as to novelty, but do not guarantee the patent when at last issued.

POPULAR NOTIONS FALLACIOUS.

The whole matter is not nearly as simple as it sounds; and it is probably owing to people treating a complicated matter as simple that so much difficulty and misunderstanding has arisen, and so much misguided legislation has come about. It is so easy to decide that there shall be a number of clever technologists employed as examiners, and that they shall look through each specification and say at once the invention is new, or that it has been anticipated by this or that. In all such cases people have in their minds a specification clearly describing some clear-cut, definite invention, and claiming it, so that the region claimed is perfectly determined, and the specification can be compared with every prior description of anything at all like it, in such a way that a competent examiner can decide without doubt whether the invention is new or old. But anyone who has had any experience of real patents knows that the matter is not simple. Inventions are invariably matters of degree. The Heaven-born genius who comes along with a brand new invention which has nothing to do with anything that went before, and which is completely worked out and in its final and only possible form, exists only in imagination. Take actual applications. There can be no doubt that nine-tenths of the patents taken out would not hold water if they came into court, but the rest, the other tenth, would involve enormous research and very great critical acumen to determine whether they are valid or not. But even the ninety per cent. that are certainly invalid would give great trouble to examiners. Many of them are invalid through being drawn up by ignorant inventors who make technical slips and all sorts of blunders. Under examination, and the resulting correspondence, the grosser errors would be removed, and the more difficult questions of novelty and subject matter would come up.

EXAMINATION ON PUBLIC GROUNDS.

In considering the question of examination, we must deal with the matter first from the public point of view. That is to say, the patent office should be self-supporting, but it should encourage invention to the greatest extent possible, without unduly hampering trade by giving undeserved monopolies. We will therefore assume that the patent office is self-supporting, that is to say that all expenses are paid out of patent fees. We need not assume that a surplus is handed over to the Treasury; that, as was pointed out last month, is a piece of political immorality of a particularly pernicious type, as it is a taxing of industry.

THE PATENTEE'S STANDPOINT.

Next we have to look at the question from the patentee's point of view. Patentees may be broadly divided into two classes, though there is no sharp division. On the one hand, we have the experienced specialist who is improving his own branch of applied science. Such a man is well up in the theory of his work, is practically familiar with all the working details, so that he appreciates the great practical differences between matters that look almost alike on paper, and he is also well up in the history of his particular branch of art, and knows not only what has been done in the past, but has a close acquaintance with all that is going on at the time he applies for his patents.

Opposed to this type as the opposite extreme, we have the ignorant inventor, generally overburdened with conceit, who takes out patents on all sorts of things belonging to all sorts of industries. He does not know what has gone before or what is already done, but he believes he has a sort of superior insight by which he can teach other people anything. He may be a schoolmaster, or a stockbroker, or a clergyman, or a mere genius. Another more pleasant and perhaps commoner type of inventor is the so-called practical man, who really does not understand his own work, and stumbles along with tremendous perseverance and often under very difficult pecuniary conditions. Most of his patents are waste paper, but every now and again he makes a real invention of great value.

SKILLED SPECIALISTS AND PATENT AGENTS.

Take the skilled specialist inventor first, and see how far examination will help him. Such an inventor generally employs a patent agent, and his specifications are not likely to contain legal flaws, unless the subject is exceedingly difficult. It has been said, and rightly said, that most of the big patent cases have been about the interpretation of specifications that have been bungled by patent agents. That only means that the good specifications which they have not bungled have not come into court. The work of the patent agents, or at any rate of those that are high in their profession, is very well done, and the younger men who have come into the profession after a pretty stiff examination will gradually raise the profession further. The patent agent is, however, in a difficult position, and we may make an apparent digression on this point, as it touches on official examination. To go on with our intelligent inventor. He is working at a particular subject, he is taking out a patent every few months; he has not unlimited funds. He does not know which of his patents will eventually be valuable. He goes to a first-class firm of patent agents. They charge him, in addition to the Government fees, perhaps eight guineas per patent. If he has special work done he, of course, pays more. Now, this eight guineas, or whatever it may be, is a fair charge for ordinary skilled assistance. Eventually the question of the validity of one of the patents may be a matter of many thousands of pounds, and when it comes into court the inventor would give any money to be able to re-draw his specification. But he cannot have each of his patents examined carefully by highly-skilled, trained intellects, nor can he afford to have all his claims settled by counsel and so on. The result is that, however able the patent agents may be, they cannot ordinarily examine and draw all their specifications with the care that a valuable invention deserves, because the inventors cannot generally afford the money necessary, or even if they can afford it, do not consider it a good investment to spend so much on a large number of patents of which few, if any, will eventually become valuable. The popular idea is that an inventor invents one definite thing and takes out one patent, and a new manufacture comes into being. But, in fact, the inventor develops his ideas over many years, and is continually taking out patents all the time. His first is a rather broad patent. Then he takes out patents for details. Then he finds his first patent is not broad enough, and takes out more patents over the various parts of a larger area, and so on. He cannot tell which patent will eventually be valuable, that is to say, which will really stop a future infringer, who is himself an inventor, and tries to get as far away from the protected region as he can. It is thus impossible for the patent agent to do more than to make the inventor's specification clear and intelligible as well as legal in form, and to help him by friendly criticism and by advice as to the best way to draw the specification claims.

EXAMINATION WITH GOVERNMENT GUARANTEE.

If the patent office undertakes examination and guarantees the patent, it must do a good deal of the patent agent's work, but not in a way that helps the inventor. For the examiners could say what is wrong, but it would not be their business to advise the patentee and tell him how to put his specification right. But the broad difficulty is that it would involve waste of time and money; for each of a number of patents, of which most will never be of any value, will have to be examined in great detail. If it does not pay each patentee to examine his specifications in this careful way, it can hardly be policy for the State to do so. If the State is to guarantee the patents, every patent must be examined and criticised with as great care as it now is when a patent action is fought. Assuming that examination by patent action is ruinously expensive, it still must be very expensive to examine properly by means of organised trained examiners, and it is waste of money to devote this expense to all patents. But does the skilled inventor want examination? As far as novelty and the real nature of his invention goes, he must know far more than the examiner. Take, as an example, any new industry or development; imagine the inventor is an expert in wireless telegraphy, and has been devoting his whole time for some years to working out his inventions, studying the very difficult theory of his subject, and watching the development of his specialty at the hands of rival inventors from week to week. He must know much more about his patents than the patent office examiner. I do not know who is the examiner in wireless telegraphy, but if he is as competent as the other examiners are, his subject is in good hands. But it is nothing against him to say that he cannot be expected to know as much about his subject as our inventor. It would not be surprising if there is no special examiner in wireless telegraphy that is to say, no examiner who devotes his attention, like our inventor, exclusively to that one subject. The question, in the case of Government guarantee, would be whether the inventor is to have his patent accepted or rejected finally by the examiner. The examiner would have an enormous responsibility on his shoulders. He must deal with a number of patents every day, and he must remember that every time he accepts one he is rendering the State liable to have to support his grant of monopoly, and he may be crippling new industries by granting monopolies to people who have not really done anything to deserve them. His interest, therefore, must be to reject whenever he possibly can, on the one hand. On the other, this cuts down the flow of fees to the department.

WHAT IS NOVELTY?

Reverting again to the popular notion—the idea as to novelty is that there is or is not a clear prior publication of the exact thing, and that the examiner has merely to look up earlier documents and see if the invention has been described before. This, again, has nothing like it in fact. There is almost never an exact publication of the most obvious invention; there is only something more or less like it, or several things resembling it in various different ways. The question is, then, whether the inventor has or has not made an inventive advance. This is a matter of judgment, and generally a very difficult matter of judgment. When a case is fought in court, generally many years after the date of the patent, when the advances are really made, and are not mere speculation, it demands a number of the ablest counsel, and the most experienced technologists as witnesses, and any time up to three or four weeks is occupied in the discussion. Admitting for the moment that the proceedings in the courts are cumbrous and expensive, they still show that the investigation of the novelty—for that is generally the main point at issue—is a very difficult matter indeed. Much more difficult is it, then, when the invention is quite new.

As one example of the difficulty of settling novelty we may take a patent for something which appears so obvious that it must be old If the article was not in use at the date of the patent, and has come into general use afterwards, the courts hold that that is proof of novelty, as the article was evidently wanted, and if it did not come into use before the patent, it must have been new. This test of novelty is obviously inapplicable at the date of application and in any case the examiners would not be in touch with industry. Such an application as this would be rejected, doing a great injustice to the inventor.

EFFECT OF UNFAIR MONOPOLIES.

No doubt many people will say that when there is any doubt the patentee should get the benefit. This is unsound, however, as a matter of public policy. It is obviously wrong to give a monopoly, or power of stifling an industry, to a man who has invented nothing. Even if we look at it only from the point of view of the inventors, it is wrong. Each patentee stands in the way of all subsequent inventors. If an early patentee, who files an unpractical specification, for example, is given a guaranteed monopoly, it practically stops all future invention. One of the most difficult questions, apart from novelty, is whether a specification describes a workable thing in language clear enough to be understood by specialists in the industry. Even after many years it is often difficult to decide whether a specification is practical. How an examiner, dealing with a completely new subject, is to say whether the proposed invention is practical or not, it is impossible to conceive.

SKILLED INVENTOR AND EXAMINATION.

Now consider again the skilled inventor. Ought his fate to be entirely in the hands of an examiner to whom his specification is only one of many coming before him daily, or should he be allowed to use his own judgment and knowledge? The inventor will naturally say, "I understand my invention much better than the examiner can, however able he may be, because I am a specialist in this subject. My invention is merely a small incident to him; to me it is a matter on which a fortune probably depends. He has brought forward an early specification which vaguely describes something like my invention, but further understanding of the subject, especially the practical working of my invention, would show he is wrong. I would therefore prefer no Government guarantee of my patent against the public, or of the earlier patents against me. I would rather trust to the full but expensive investigation in the law courts, if there is any question of the validity of my patents later on."

FEES AND WASTE PAPER.

But the skilled inventor only represents some small fraction of the applicants for patents. The result is that the patent office at present takes fees for, and accepts many thousands of specifications which are waste paper. But does this matter very much? We often read letters from people who complain that the patent office has no business to accept fees for patents which the officers know or ought to know are worthless. But this is a wilful misunderstanding of the relation of patent fees to patents. The fee is not the price paid for a monopoly. The fee is nominally to cover office expenses. It is really also a tax on industry. But it must be admitted that if this tax were removed we would have still more useless patents. The price the inventor pays for his monopoly is the work he has devoted to his invention, not the fee he pays for the formalities of the office. To say that the State should guarantee patents because they charge £4 fees is analogous to saying the State should guarantee that an agreement is not broken if money has been paid for a stamp, or that a limited company is to be financially sound because the Somerset House fees have been paid. To pass thousands of patents, most of which will be useless, may do comparatively little harm. But to go to the expense of examining all of them seriously, and discussing patents for inventions which will be immediately superseded by better inventions, with the care that ought only to be spent on really important matters, means very serious waste of public money. The patent office ought not to be an organisation for the assistance, by advice, of incompetent inventors. Many inventions now are really due to the patent agents, who lick their clients' work into shape and cut out useless things and straighten out the inventors' ideas in a logical way. It can never be the duty of a Government department to do this for muddle-headed inventors, and in practice patentees are often muddle-headed. In short, to recapitulate, examination combined with Government guarantee of the patent means that there will be a tendency to disallow good patents; that industry will be hampered by the allowance of bad patents; and thorough examination will be impossible, and what examination is possible will be much more expensive than will pay.

GERMAN AND AMERICAN METHODS.

It may be urged against these conclusions that Germany does examine, and Germany does guarantee patents. But no one who has had to do with the German Patent Office would say the system is satisfactory. Both in Germany and in America it takes a great deal of energy and considerable perseverance and an appreciable pecuniary depletion to get a patent through. It is not the fault of the examiners, they have an exceedingly difficult task. The great difficulty is to explain differences that are vital in practice, but do not look important on paper. A patent for using tinned iron wires for sealing into incandescent lamp bulbs, for instance, was rejected because a paragraph in a paper said that a fusible alloy of tin and some other metal adheres to glass. The alloy, of course, could not be sealed into a bulb, as it is fusible; but clearly the examiner did not understand anything about incandescent lamp problems. An appeal might have been lodged, but then the matter would have been referred not to experienced technologists but to some university professors who would have no knowledge of the subject at all. This would have cost more, too. Finally, somebody else invented a better wire, so there was no real loss except the labour of trying to get the patent through, and the cost of examination to reject it. If I remember right, Germany does not trust the examination entirely. A patent may be questioned as to validity during the first five years of its life by outsiders. This is obviously wrong. Either the examination is thorough or it is not. In practice, of course, it is not. But why should a bad patent become good because no one has been interested in opposing it for five years? An industry may develop slowly, and perhaps in another country. When it is developed the inventor wants to work it in Germany, but finds that though his invention was not mentioned before, a broad patent, describing nothing practical and nothing new at all, has existed for more than five years, and covers his manufacture without disclosing it.

SHOULD THE PATENT OFFICE EXAMINE WITHOUT GUARANTEE?

The next question is whether the patent office should examine without guaranteeing the patent. Such an examination must be in a way irresponsible. The question is whether it is a benefit worth the expense. This system is carried to a high state of perfection in America. The examination in America is as searching as in Germany, but it is not so difficult, as the American examiners seem to be—if one may say so without disrespect to the Germans—more practical. In both countries they begin by quoting everything that by any kind of twisting up can be construed to relate to your invention.

This is generally supposed to be a way of finding out if you are really serious in wanting a patent. When you have fully explained the difference between things with no point of resemblance, a matter which is not always very easy, they send you things which are verbally like yours, but essentially different; at intervals they say your specification contains seventeen different inventions, needing seventeen separate applications, and that you are claiming things that are unclaimable and so on, and then the real work begins. When you eventually get as many of the seventeen patents as you think it expedient to invest in, you are probably very much better off than you would have been with a grant on your original specification, but the process is expensive to patentees and to the public.

THE STATE AS PATENT AGENT.

The broad question is whether the State should do the work of patent agents, whether the patentee likes it or not. When the examiner has power not only to advise, but to reject, very serious injustice may be done. There is a standard case of an early inventor being refused a patent for the ordinary transformer of to-day, because the examiner could not understand it at that time; but, of course, we only have one account of the matter, as the examiner cannot well give his. But the probability of such cases is great, without any fault on the part of the examiners. If the examiner has no power to reject, the examination is a great benefit to inventors. It is only a question of public policy whether the State ought to help inventors in this particular way.

THE NEW BILL.

The new Bill provides for examination as to novelty as far as past British specifications are concerned. On the one hand, this will be a great help to inventors. But this sort of search is very easy already, as the patent office publishes illustrated abridgments, which make this matter very easy. It would be a very good thing for an inventor who is ignorant of the history of his subject, to go through these abridgments himself. He would then know very much better how to draw up his specification. On the other hand, if the patent fees remain the same, it will be a benefit to industry to have the money spent on behalf of patentees, rather than absorbed by the Treasury. The great objection to the system is that people will think a patent is valid because it is allowed. The search is only as regards novelty, and even then it is incomplete. A prior publication is just as fatal in a foreign specification, or in the general literature of any country, provided a copy came to this country. The examination as to novelty will therefore be useless as a guarantee of novelty, though it may save many patentees who would otherwise re-patent old things. In addition to this want of novelty a patent may be bad on several other grounds. The specification may not describe a practical invention, or it may claim something which is not of a class that can be patented, that is to say which is not a patentable invention.

A SERIOUS DIFFICULTY.

One of the most serious difficulties as to novelty has not been dealt with at all, but it is a little difficult to explain. The question of whether a patent is valid or not is of no importance in itself; it is only important when there is a question of infringement. Now, almost every claim is capable of a broad or a narrow interpretation. If the patent is examined without any reference to a given alleged infringement, the patent may easily be passed as being for a novel invention on a narrow interpretation. Later on a rival makes something which is outside the narrow interpretation of the claims, but really takes what the inventor considers is his. He then says his patent covers his rival, as he is infringing his claims on their fair interpretation. According to present practice the patent is dealt with by the courts with the early history of the act on one side, and the alleged infringement on the other. If the claim is interpreted broadly enough to cover something that went before, the patent is void; if it is narrow enough not to cover what went before, there may be no infringement, in which case the patent may be useless though valid. It is thus really impossible to settle the question of novelty without having the alleged infringements before the umpires at the same time. The patent office examiners are therefore necessarily unable really to decide as to novelty, whether the Government guarantees the patents or not.

CONCLUSIONS.

To sum up, then, examination to determine novelty by the patent office, with power of rejection, is unsatisfactory in the case of skilled inventors, because they may have injustice done them owing to the examiners not being sufficiently skilled. Of course, the law courts may also be unintentionally unjust, but with the fuller investigation there undertaken, this is not so likely. If the examiners have power of rejection, no end of irreparable injustice may be done to all kinds of inventors by ill-advised rejection of really good applications. If the examination is thorough it is great waste of money, as thousands of patents have to be examined which are of no importance, because the inventions, even if apparently good, never come into use, or are superseded by others before there is any question of infringement. Finally, no examination can be conclusive when an invention is new. The inventor must be ahead of the examiner, or he would not be an inventor, and, apart from that, the examiner cannot form any true view of the invention, because a little time is necessary to give the distance necessary for true perspective.

Examination without guarantee of validity and without power of rejection, such as proposed in the new Bill, is an unnecessary expense to the patent office; but if it is carried out by reducing the surplus now paid to the Treasury, instead of by raising fees, it certainly would be a great benefit to inventors.

THE NEW ANCHOR LINER "COLUMBIA."

[illegible]

A STEAMER which is not only a distinguished example of marine architecture in itself, but which also marks the occurrence of the jubilee of one of the world's historic "Lines," deserves more than passing notice. Such is the new twin-screw *Columbia*, of the Anchor Line, one of the latest products of the large shipbuilding and engineering establishment of D. and W. Henderson and Co., Limited, Meadowside, Glasgow. This yard is one of the oldest on the Clyde, being that in which early in the last century Messrs. Tod and Macgregor built many famous pioneers of the ocean trade. Though the site is the same, the equipment of the present establishment is very different from that of the old firm, who are regarded as the "fathers of iron shipbuilding," because they built the first iron sea-going vessel—the *Royal Sovereign*—some sixty-three years ago. Here also was built the first iron paddle steamer run by the P. and O. Company, the *Trafalgar*, with oscillating jet condensing engines of 370 i.h.p.—a figure that compares strangely enough with the 10,000 i.h.p. of the latest P. and O. liners.

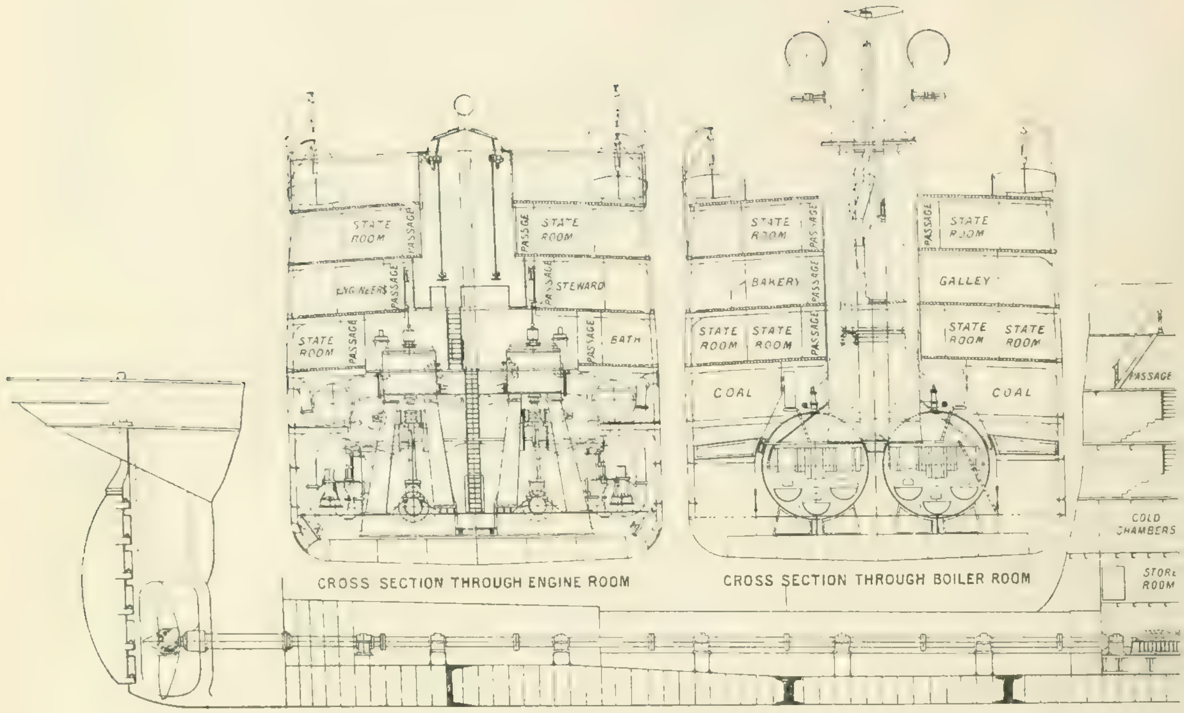
At Meadowside, too, Messrs. Tod and Macgregor, in 1850, built the *City of Glasgow*, famous as the pioneer iron screw steamer in the Atlantic trade. She was built for Glasgow owners, but was afterwards bought by William Inman and Co., Liverpool, and became the first vessel of the historic Inman Line. It is interesting to recall that she was 220 ft. in length, 32 ft. in breadth moulded, and 21 ft. in depth moulded. She was of 1,600 tons, and had overhead beam engines, jet condensing, of 310 h.p., with two cylinders 66 in. diameter and 60 in. stroke. About the same time the Anchor Line was founded by Messrs. Handyside and Henderson (now Henderson Brothers), Glasgow, who opened a direct trade between the Clyde and the Mediterranean with the little sailing vessel *Vasco da Gama*, of something under 200 tons. The Anchor flag now floats over a large fleet of up-to-date boats trading regularly between Glasgow and New York, the Mediterranean and the Clyde, the Mediterranean and North and South America, India and the Clyde, and between India and New York.

From the *City of Glasgow* of 1850 and the first iron Anchor Line steamer of 1852 to the new member of the fleet is a tremendous stride.

THE "COLUMBIA'S" ENGINES.

The *Columbia* is 500 ft. long, 56 ft. broad, and 36 ft. 6 in. deep. She has accommodation for 325 first-class passengers, 220 second-class, and 600 third-class or steerage. She carries a cargo of 5,350 tons on a draft of 25 ft., this being limited to enable her to navigate the River Clyde right up to Glasgow. She is driven by two sets of triple-expansion engines, of which we show a drawing. Each set has three cylinders, which are 31½, 51½, and 85 in. in diameter, respectively, with a piston stroke of 54 in.

The cylinders of each engine are rigidly bolted together, and stand on six massive cast iron columns. The front or inner columns are of rectangular section, and are divided at the bottom for the double purpose of giving fore and aft rigidity to the engines. By permitting the cranks to pass between the column feet, ample room is provided on the starting platform between the two engines. The back columns are of cylindrical section, with sufficient taper in their length to provide ample area at their bases. The sole plates are made in three pieces bolted together. They are of



hollow rectangular section, and have strong flanges at the bottom for fixing the engines to the top of the ballast tank. The crank shafts are made in three interchangeable parts, and are of the built type. Each part is carried on two bearings of extra length, and is lined with white metal; and, indeed, the bearings throughout the entire engines are made with extra large surfaces. The crosshead guide-plates on the columns are of hollow section, through which cold water circulation is provided.

AIR PUMPS.

The air pumps are on Edward's patent system, and are fixed to the back columns of the intermediate engines, from the crossheads of which they are driven by means of the usual levers. Attached to the air pump, one at either side, and driven by the same crosshead, are two bilge pumps.

CONDENSERS.

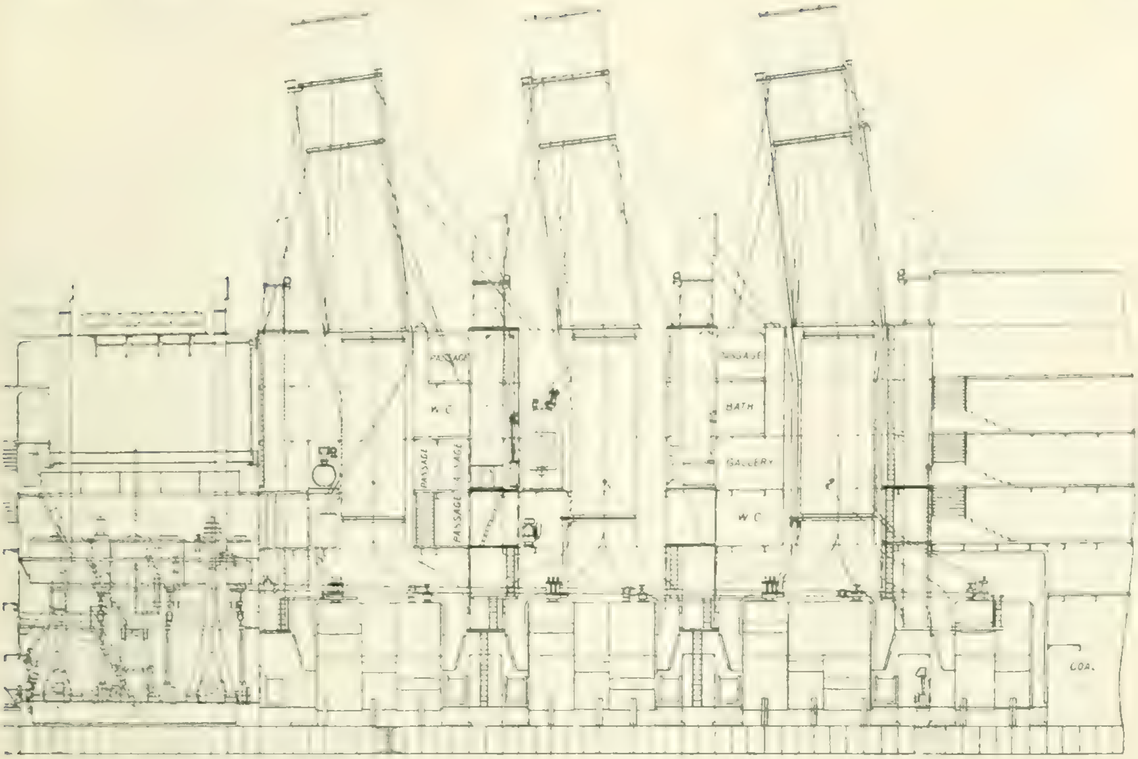
The condensers are carried on the lower deck beams close to the side of the ship, and quite separate from the main engine structure. The cold water circulation through them is supplied by two large centrifugal pumps driven by vertical steam engines, and placed on the level of the starting platform between the low-pressure engines and the ship's side, the diameter of the delivery pipe being 16 in.

FEED-WATER HEATERS.

There are no feed-pumps driven direct by the main engines, the whole of the water necessary for feeding the boilers being supplied by two pairs of Weir's feed-pumps of large capacity, either pair being sufficient to provide the entire feed-water required. To each set of pumps there is a pipe leading from the hot-well to a float-tank with automatic control valve ; one pump taking the water from this float-tank passes it through an Alley and MacLellan's "Sentinel" feed-filter, and then into one of Weir's patent direct contact feed-heaters, from which the other pump draws the heated water and delivers it through the main line of feed-pipes to the boilers.

REVERSING GEAR.

For the rapid manipulation of the main engines in narrow waters a direct-acting, steam-reversing engine is provided, the cylinder of



which is attached to the back of the main cylinders immediately above the Wyper shaft, to which it is directly connected, and controlled by levers from the starting platform. The gear for regulating the main stop valves is placed close to the reversing levers. To permit of the accurate adjustment of the main stop valves, a screw gear worked by a hand-wheel is provided; but, in case of emergency, the steam can be instantly shut off the engine by simply pulling a lever.

THRUST BLOCKS.

At the after-end of the engine room is the thrust recess, which extends from side to side of the vessel. In it the thrust blocks are secured to steel seats built upon the ballast tank top. The thrust of each propeller is taken up by collars on the thrust shaft, bearing upon ten horse-shoe rings with large white metal bearing surface.

TUNNEL SHAFTING, ETC.

The tunnel shafting is made up in five convenient lengths, each carried on a pillow block with white metal lining. The propeller shafts, which are carried inside the skin of the ship right up to the stern frame, have, on this account, to be of extra length, and, to avoid corrosion where they are exposed to the salt water in the stern tubes, they are covered by gun-metal liners, extending from the fore end of the stern tube to the propeller bosses. The propeller bosses are of cast iron, and to each are secured, by studs and nuts, four bronze blades. The propellers are 17 ft. 9 in. in diameter.

In the thrust recess, between the two thrust blocks and immediately below the cold-storage chamber, is fitted a Hall's patent refrigerator of large capacity on the CO_2 principle.

ELECTRICAL MACHINERY.

Here also is placed the electrical machinery, of which there are two complete sets on opposite sides of the ship, either set being capable of lighting the whole ship, as well as of driving a large number of powerful electric fans, which are provided for ventilating purposes.

The dynamos are driven direct by vertical compound steam engines, the steam and exhaust pipes of which are independent of all other machinery.

PUMPS.

The pumping arrangements are on a very complete scale, and comprise two extra large duplex ballast pumps, one on either side of the engine-room. The ballast and bilge pipe connections being in duplicate, there is a complete system on either side of the vessel with connecting pipes at the after end of the engine-room. The two pumps may either work independently, or both may be connected to draw any one compartment of the vessel. By this arrangement it will be seen that in the event of a considerable leak occurring in any part of the ship there is ample provision for dealing with it.

In addition to these pumps there are two separate duplex pumps for pumping fresh water up to the service tank on the top of the engine casing for supplying the lavatories, galleys, pantries, etc. There is also a duplex pump for the supply of salt water to the sanitary tank, and another for fire purposes, in accordance with the requirements of the American authorities. All these pumps are by Messrs. Lamont, of Paisley.

BOILERS.

Steam is supplied by six large double-ended boilers and one single-ended boiler. These boilers are on the natural draft system, and are arranged in pairs, with a funnel to each pair, the forward funnel also acting for the single-ended boiler. The funnels are 107 ft. high, and have an outer casing throughout their entire length. There are in all thirty furnaces, giving a large heating and fire-grate area. The main steam pipes are led in duplicate, each engine having a separate pipe the whole length of the boiler space. A valve is fitted on the forward side of the forward engine-room bulkhead connecting these pipes for the purpose of equalising the steam pressure of the engines.

The placing of the boilers in pairs permits of the use of side bunkers throughout the entire boiler space. These bunkers are of sufficient capacity to steam the vessel across the Atlantic, and by this arrangement, the coal running naturally to the place at which it is required, the necessity of coal trimming is greatly reduced.

The boilers are of Siemens-Martin steel, and are fitted with thirty-nine Morrison's patent withdrawable furnaces. The total heating surface equals 30,000 square feet.

DECK MACHINERY, ETC.

For dealing with the large cargo the vessel is designed to carry, ten powerful steam winches of the builders' own special make are placed on deck. These have cylinders of 7-in. diameter and 12-in. stroke, and are provided with winding barrels of extra large diameter.

In addition to the large fresh-water tanks, a large distilling plant for condensing salt-water is provided, and a separate tubular boiler is fitted in the boiler casing abaft the centre funnel for supplying the necessary steam.

The steam steering-gear is fitted in a special house on the poop, and is worked from the bridge by a controlling shaft. It is of Caldwell and Co.'s make, and is of great power. The hand steering-gear is arranged in the same house, and a Cumming's patent oil cylinder rudder brake is also fitted.

SATISFACTORY TRIALS.

When on her trials on the Clyde the *Columbia* attained a speed of 18¼ knots loaded, which is considerably in excess of what she was required to do, and everything has worked with the most satisfactory smoothness on her subsequent maiden voyages both ways across the Atlantic.

The advantages gained by the progress that has been made in naval architecture since the *City of Rome* was built in 1881 are obvious on looking at the capacity of the two vessels as compared with the measurements, especially when it is remembered that the *Columbia* is an eight-day boat, leaving Glasgow on the Saturday afternoon and arriving at New York on the Monday morning.

COMPARISONS.

The *Columbia* is an exceptionally fine-looking vessel. She has a straight stem and elliptical stern, two schooner-rigged pole masts, and three tall funnels. She is divided into nine water-tight compartments. The passenger accommodation is distributed throughout six decks, so that the work of administration can be carried on with the greatest advantage to the passengers. The first-class rooms are specially luxurious, and the saloons are magnificently furnished and decorated, while the second-class state-rooms and saloons are almost as comfortable, though less finely decorated. In the third class there are more berths in each cabin, and there is little in the way of decoration, but the owners have provided all kinds of comforts in the matter of bedding, napery, and eating utensils, so that a voyage third-class in the *Columbia* has fewer terrors for the landsman than a voyage first-class in any Atlantic liner had a few years ago.

It is now over fifty years since the old *City of Glasgow* sailed on her maiden voyage from the Clyde, and a comparison of the dimensions and tonnages of the two steamers affords a fair indication of the growth and development of the Transatlantic trade since 1850 :—

	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Engines ...	Overhead beam ...	Twin-screw.
Description ...	Jet condensing ...	Triple-expansion.

ANOTHER COMPARISON.

It is twenty years since the well-known *City of Rome* was taken over by the Anchor Line and placed on the Clyde and New York summer service. There is a marked difference in some respects between the *Columbia* and the *City of Rome*, so long associated with this service. The *City of Rome* was not built originally for the Clyde trade, but for the Liverpool trade; and while she has traded for many years from the Clyde, she has not been able to come much above Greenock except for dry-docking purposes. On comparing the two vessels, one notices in the *Columbia* the absence of the beautiful curved bow, with the handsome figurehead of Julius Cæsar and other externals, that went to cause the *City of Rome* to be regarded generally as the handsomest vessel engaged in the Atlantic trade. There are other striking contrasts between the *Columbia* and the *City of Rome*. The *Columbia* carries a larger cargo on a more moderate draft of water. The *City of Rome* has compound engines; the *Columbia* has triple expansion. The *City of Rome* works her boilers at a pressure of 85 lbs.; the *Columbia* works hers at a pressure of 180 lbs. The *City of Rome* has one propeller; the *Columbia* is a twin-screw. The coal consumption of the *Columbia* is very nearly one-half that of the *City of Rome*. The changes that have taken place in twenty years are all in the direction of economy and safety.

WORKSHOP PRACTICE

A RESUME OF MACHINE TOOLS, CRANES, AND FOUNDRY MATTERS FOR THE MONTH.

A NEW LATHE.

THE appearance of a new automatic machine is always a fact of interest in the trade. A lathe of this class is now being manufactured by Mr. J. Parkinson, of Shipley. The following is a description of its principal movements, illustrated by outline drawings.

The machine, it should be observed, is not intended to compete with those that produce threads by screwing dies, but is designed for the production of those classes of screws which can be best, or most suitably cut in a screw-cutting lathe. It may not be supposed to be capable of turning out more work than can be performed by a skilled man, doing his best under the most favourable conditions, yet it will perform automatically and with absolute precision all that the best workman can do at his best continuously. Besides this, two or more machines can be operated by one attendant.

The principal points are these : The spindle rotates in one direction continuously. The various movements, save one, are driven through the lathe spindle, so that the sequence of motions of the mechanism is not affected by variations in the spindle speeds. The movements which are thus controlled are the setting in and withdrawing of the tool, and engaging the clasp nut with the lead screw. The exception is the running back of the saddle for starting another cut, which is performed at a uniform speed for all screws, and this is also made self-arresting, independently of any mechanism operated by the spindle. Threads of any section, right or left hand, are cut. The feed of the tool operates automatically, and is tripped also automatically after the desired depth of thread has been cut.

A valuable feature of this machine is that multiple threads are cut automatically, the tool catching the threads at the precise period required for two, or three threads, etc., and in but little more time than that required for single-thread screws. To those who know the difficulty of catching threads correctly, and the crude device of marking the change-wheels for the purpose, this alone is a very valuable provision. It is effected by a special mechanism,

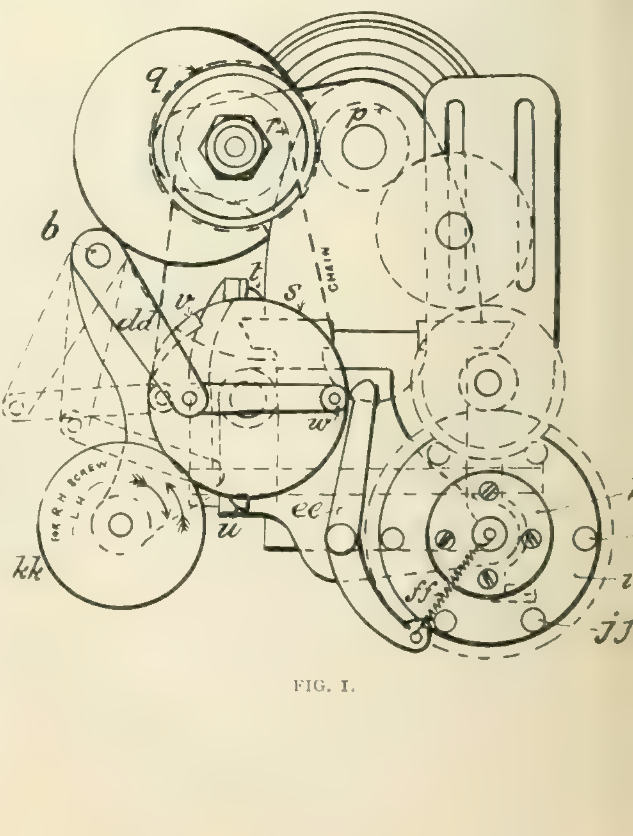


FIG. I.

the leading element in which is a loose ring attached to a driver-plate, and a pawl. The motion of the ring is arrested for half a revolution for two-threaded screws, and for a third of a revolution for three-threaded screws, and so on. The loose ring carries projections which strike the dog on the screw to be cut, and cause it to rotate. Notches are made in the driver-plate to correspond with the number of threads required.

The main operating mechanism of the lathe comprises a lead screw, and two shafts, one in front beneath the lead screw, and one at the back. The latter receives motion from the countershaft, and drives the shaft in front by a Renold chain—an example of the growing popularity of the chain drive, with its advantage of positive movement without chance of slip.

Figs. 1 and 2 show the lathe arranged for cutting right-hand threads. The adjustments being made, the shaft to be threaded is placed between the centres. The lathe, being started, commences to take the first cut. When the tool has reached the point for withdrawal, a projection on the saddle comes against an adjustable collar, *a* (fig. 2), on the controlling rod at the front of the bed. This operates mechanism which causes the shaft, *b*, at the rear and above the lathe bed to make a partial revolution, and thus by the crank, *c*, and a connecting link, *d*, to push the tool-slide away from the lathe centres. This movement of the tool-slide opens the clasp-nut, as will be noted on reference to figs. 3 and 4. At *e* (figs. 3 and 4) is shown the cam-shaft, the partial rotation of which closes or opens the halves of the clasp-nut, *f*, by means of the cam-plate, *g*. On the left hand end of the cam-shaft, *e*, is fixed a lever, *h* (fig. 3), on the boss of which is loosely fulcrumed a lever, *i* (figs. 2 and 3), so that both may move together, or the nut be opened by hand, if desired. Lever, *i*, is connected by link, *k* (figs. 2, 3, and 4), to the left side of the tool-slide; and thus the movement of the latter away from the lathe centres simultaneously causes the clasp-nut to open and release the screw. The movement of the tool-slide being continued a little further, causes the cam, *l* (fig. 4), which is connected with the lever, *i*, by the link, *m*, to slip a revolving bevel pinion, *n*, into gear with a wheel, *o* (figs. 2 and 4), and that drives a train of gearing in the apron, which, acting against the

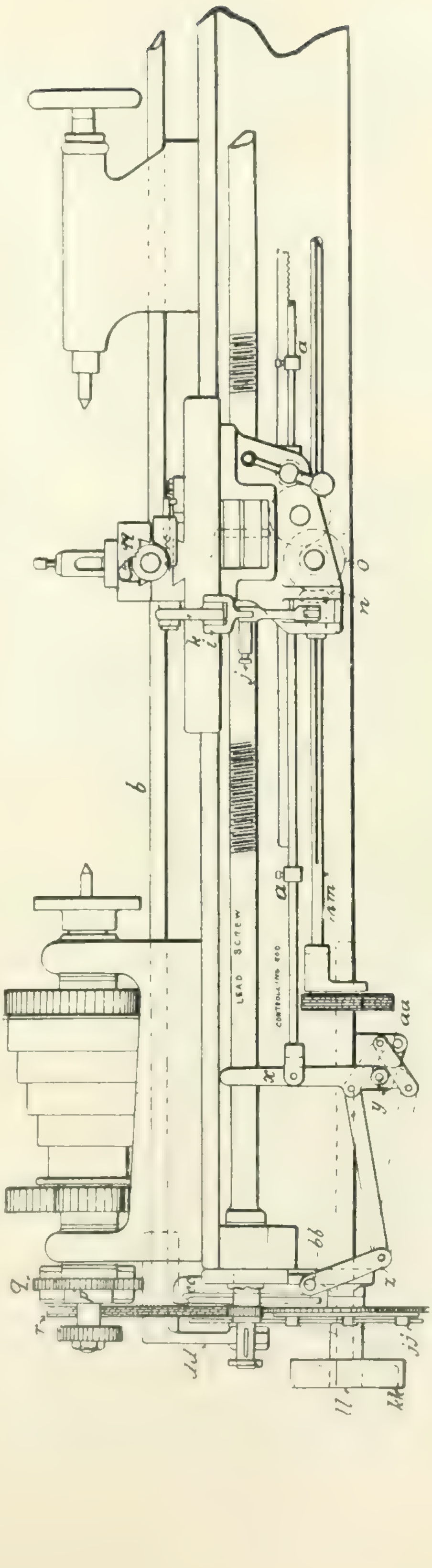


FIG. 2.

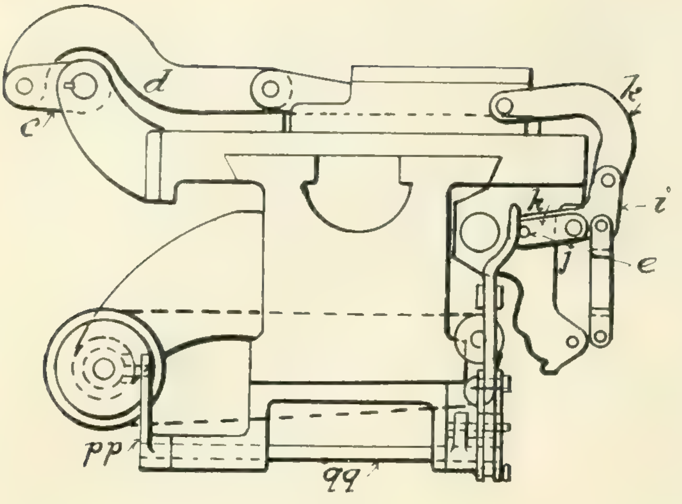


FIG. 3.

rack on the front of the bed, returns the saddle rapidly to the starting point. Just before reaching this position, however, the saddle strikes the collar, *a*, on the right hand side of the saddle, and again trips the mechanism for giving the reciprocating rotary motion to the shaft, *b*, which now pulls the tool slide towards the lathe centres. Simultaneously with this, the rotation of the shaft, *mm*, at the front of the bed, and which drives the sliding bevel pinion, *n*, is arrested, as will be explained presently, and thus the saddle comes to rest.

The next operation is to catch the thread, and to understand how this is effected we refer to fig. 1, which is an end view of the lathe. On the end of the spindle there is the driving change-gear, which actuates the driven wheel on the lead screw, through the usual train of gearing, carried on a quadrant plate. The latter is omitted from fig. 2 for the sake of clearness. Behind the change-gear on the spindle is another spur-gear, *p*, driving a spur-gear, *q*, which runs between friction discs; attached to one of these there is a chain wheel, *r*, which drives, by means of a Renold silent chain, the wheel, *s*. This wheel has on each side a disc, the inner one having two projections or catches, *t*, *u*, diametrically opposite, and the outer one a notch, *v*. A stud or crank pin, *w*, projecting through the outer disc, by a link connection actuates the lever, *dd*, on the end of shaft, *b*.

Turning again to fig. 2, the controlling rod is seen connected at the left with a lever, *x*, fulcrumed on the stud, *y*. This in turn is connected by links to the levers, *z* and *aa*. The lever, *z*, is keyed on a rocking shaft, to the outer end of which is keyed the lever, *cc*, which has a projection or catch, overhanging the inner disc of the wheel, *s*. Thus, the lateral movement of the controlling rod causes the lever, *cc*, to come within the path followed by one of the catches, *t* and *u*, as the wheel, *s*, rotates, and to arrest the rotation, the slipping of the friction discs against the wheel, *q*, allowing this to take place. These catches are so placed that as the lever, *cc*, is moved from the path of the catch, *t*, it comes into that of the catch, *u*. It is thus impossible for the wheel, *s*, to make more than half a revolution at each release.

Thus the movement for withdrawing the tool is effected, first by the saddle moving the controlling rod to the left, which causes the lever, *cc*, to release the catch, *t*, and allows the wheel to make half a revolution, or, until the catch, *u*, strikes the lever, *cc*. This movement throws the lever, *dd*, on shaft, *b*, to the outer of the two positions shown by the dotted lines, at the same time giving the shaft, *b*, its extreme movement in one direction, withdrawing the tool slide, releasing the lead screw, and returning the saddle towards its original position, just before reaching which, as already shown, the controlling rod is moved to the right, the catch, *u*, released and the shaft, *b*, rotated a portion of its movement, sufficient to slide the bevel pinion, *n*, out of gear with the wheel, *o*, fig. 2. This time however the wheel, *s*, is only allowed to make about one-sixth of a revolution, the notch, *v*, being caught by the hook on the double-ended lever, *ee*, which is held against the periphery of the disc by the spring, *ff*. The lever, *dd*, is thus arrested in the intermediate position, shown by dotted lines, and with the tool, lead screw, and bevel pinion disengaged.

Immediately below the lead screw, and driven by a small pinion upon it, is a spur-gear, *gg*, so arranged that it makes only one revolution to twelve of the lead screw. Clamped to this gear by the plate, *hh*, is a disc, *ii*, carrying twelve studs, *jj* (six only are shown), which come in turn against the inclined ends of the lever, *cc*, and cause it to trip out of the notch, *v*, and release the wheel, *s*, which is then free to make the half revolution required to draw in the tool slide, and engage the lead screw.

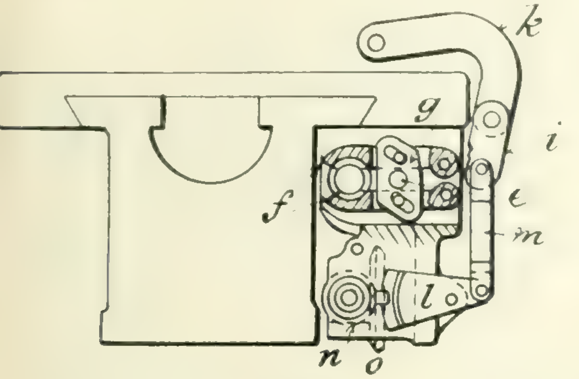


FIG. 4.

It will now readily be seen that the exact point at which the threads of the lead screw are engaged, is determined by the position of the studs on the disc, *ii*, and, as already indicated, these may be readily set to trip the lever at any desired point. The lead screw has two threads per inch, and it follows that in cases where the threads to be cut coincide with the lead screw, every half-inch engagement may take place correctly at each revolution of the latter, and all the twelve studs may remain in, each one corresponding to one revolution of the screw; but if the threads to be cut only coincide with every other thread of the screw, then six of the studs must be taken out; if every third, then only four opposite studs remain; if every fourth thread, three studs equally spaced are retained. In this way, for any pitch that coincides with the pitch of the lead screw, anywhere within six inches, the thread is caught correctly.

The motion for running back the saddle is driven by a separate belt (crossed for right-hand screw) from the countershaft, on to the pulley, *kk* (figs. 1 and 2), mounted on the shaft, *ll*, which transmits the rotary motion through a Renold chain to the shaft, *mm*, at the front of the lathe. The chain wheel, *nn*, driven by the shaft, *ll*, is not fixed directly thereto, but is driven by clutch projections on the disc, *oo*, which slides on a key, being moved in or out of contact with the corresponding projections of the wheel, *nn*, by the lever, *pp* (figs. 3 and 5), which is fixed to a shaft, *qq*, carried in a bracket beneath the lathe bed. To the front end of the shaft, *qq*, the lever, *aa*, is fixed, which, as already stated is connected as shown by a link to the lever, *x*. The movement of the saddle when returning to its original position, thus not only actuates the lever, *cc*, and releases the wheel, *s*, but, immediately after doing so, it throws the clutch, *oo*, out of gear, and automatically arrests its return movement. The lever, *pp*, is acted upon by a spring, not shown, which brings the clutch projections of the wheel, *nn*, and disc, *oo* (fig. 5), into contact, so that the shaft, *mm*, again commences to rotate, just before the withdrawal of the tool.

For cutting left-hand screws, the direction of rotation of the lead screw is changed, the pulley, *kk*, is driven by an open belt, and the points of connection with the lever, *x*, of the links which connect the two levers, *aa*, are transposed, as shown by dotted lines.

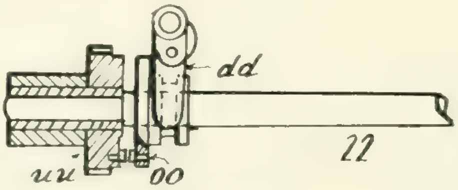


FIG. 5.

The rapidity of the work done by this lathe may be judged from these facts: A single-threaded screw in iron, 1 in. diameter, with right and left hand threads, each 6½ in. long, was cut in ten minutes; a double square-threaded screw in iron, 1 in. diameter, 16 in. long, was cut in nineteen minutes; a very deep square-threaded screw in steel, 1⅞ in. diameter, and 2 ft. 3 in. long, was cut in forty minutes.

MACHINE TOOLS.

The shops of the Cincinnati Milling Machine Co., whose recent designs are illustrated in this month's article on "Milling Machines," have a system of compressed air laid throughout for the purpose of cleaning chips from work in progress. All machine tools and vice benches are supplied with branches, and each branch terminates in a nozzle, having a valve closed with a spring, opened by the pressure of the thumb. Among the advantages gained besides that of cleanliness, is higher rates of feed to cutters, which could not be obtained if the work were clogged with chips. It is noteworthy that another firm applied an air suction to a slab miller some years ago, the chips being sucked up, instead of being blown about to the detriment of bearings and slides.

Messrs. Ward and Co., of Birmingham, have brought out a new double-cutting planing machine. A single tool is used having two cutting edges, one at back and one at front, the end being concave to give clearance. Both edges are ground at one operation, to ensure uniformity. The swinging of the tool box to bring the tool edges alternately into action includes side and under cutting, as well as horizontal, effected by two pivots, vertical and horizontal respectively, and both are regulated by the feed mechanism.

A good deal of ingenuity has been expended in designing combination machines, once more popular than they are at present, for the modern tendency is in the direction of specialising and limiting the operations of machine tools. But the universal tools always afford an interesting study. One of these has been designed for the use of Navy artificiers, and made by the Process and Engineering Co., of Farringdon Road, E.C. It is a self-acting, sliding, and surfacing lathe, swinging 60 in. and 14 in. between centres. It is also both a horizontal and vertical milling machine, and a profiling machine, a shaper, and slotter, and a boring machine.

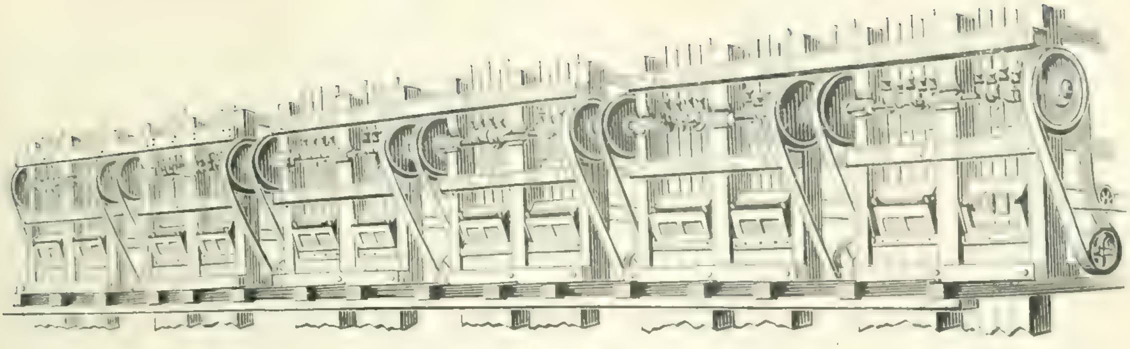
NEED FOR A FOUNDRYMEN'S ASSOCIATION.

Though a good deal has been accomplished recently in remodelling our foundries, there are still far too many—the majority, in fact—which are destitute of modern appliances, and lacking an intelligent class of men. There is nothing here like the American Foundrymen's Association, which is composed of leading men in the trade, proprietors, and foundry managers, who meet in convention once a year—as the members of the Institution of Mechanical Engineers do here—at some industrial centre, and read and discuss papers and visit establishments. The American Foundrymen's Association now numbers 314 members, with an income for the last year of $2,353. The papers read are practical, written by men from the shops, and discussed from the standpoint of the practical moulder, in plain, forceful language. Technical knowledge is much in evidence, but only that which bears directly on foundry matters, chiefly the chemistry of cast iron, the chemistry of the cupola, and so on. Such an association of managers makes its impress on the men, and sharpens the friendly rivalry of the shops.

A familiar sight at the core bench is the straightening of crooked wires pulled out of the cores by the fettlers. This is a boy's job, getting the kinks and bends out with hammer blows. A time-saver recently invented is an American machine for performing this work. The wires are drawn through grooves in rolls made to suit wires of various gauges, the grooves being corrugated to bite the wires. The lower roll is stationary, the upper one is movable against the downward pressure of coiled springs.

GERMAN CRANES.

In our last issue we alluded to the German activity in the manufacture of machine tools. We now have occasion to mention the crane industry, the particular incident which justifies it being the fact that a German crane is being built for Messrs. Wm. Beardmore and Co., right in the centre of the Scotch crane industry. It will be an electric crane of 200 tons power. We do not know whether this is a question of price, or of time of delivery, or what else, but we have for three or four years past anticipated that the rivalry of American and German crane makers will prove as serious as that of the machine tool makers has. Our insular position narrows the observations of the average man, but those who are closely in touch with crane work know that German cranes have many good points, that German engineers were first in the field in the successful electric driving of cranes, and that they are still more advanced in that field than we are. Moreover, they have made a speciality of certain types which are now in high favour, chief among which is the portal, or gantry crane. They are well represented in London, and probably will be more so as business develops.



60-STAMP GOLD MILL.

MODERN PRACTICE IN MILLING AND AMALGAMATING.

BY

EDGAR SMART, A.M.I.C.E.

THE variations of milling practice in different parts of the world present some remarkable contrasts. A mining expert making a tour of the globe, and travelling either eastward or westward from the eastern side of Australia, say from the Charters Towers Goldfield as a starting point, will find that the amount of ore crushed in stamp mills, reckoned per stamp per day, gradually increases until he reaches the goldfields of the Transvaal. The following figures, which represent approximately the stamp duty obtained in several mining countries, will fortify the above statement :—

	Per stamp per day.
1. Charters Towers, Queensland	about 1¼ tons.
2. New South Wales .. .	2 to 2¼ tons.
3. Victoria .	2½ to 3 tons.
4. Western Australia	3½ to 5 tons.
5 Witwatersrand	5 to 6½ tons.
6. United States .	4 to 5 tons.
7. New Zealand	1½ to 2½ tons.

The reasons underlying the remarkable differences which are observable in the above figures will be set forth in this article, at least in part ; and afterwards by discussing, somewhat in detail, the more important of the several divisions of the subject, it will be shown how and why the high stamp duty is obtained in the Johannesburg mills.

LOW RATE AT CHARTERS TOWERS.

As regards the first-named district, Charters Towers, the following explanation of the low duty was given to the writer by a man intimately connected with mining in the district. The majority of the miners hold strongly to the opinion that a high rate of crushing necessarily reduces the percentage of gold caught, and, as will be seen later on, this may be true if the higher stamp duty is achieved by means which are unsuitable for the ore which is to be crushed. As the batteries on this field are largely run as customs mills for public crushing at a fixed charge per ton, while the gold won is taken by the owners of the ore, the work has to be carried on in accordance with the wishes of the customers, and for this reason the speed of running is limited to 60 drops per minute. Of course, under these circumstances it is not surprising to find that the methods now in use show little trace of the advances which have been made in other countries.

EMULATION LACKING IN N.S.W.

In New South Wales up to the present time the gold mines have been, generally speaking, worked on a small scale, a thirty-head mill being considered to be a fairly large undertaking.

This is because the gold is found either in shoots or patches of limited extent, although sometimes of great value. Consequently, the amount of development work is large in relation to the ore bodies opened up, and it is therefore impossible in most cases to keep a large mill continuously running. The batteries also are scattered widely apart, and as there is no regular official publication of the results obtained, there is an absence of that beneficial spirit of emulation among millmen which is found in crowded mining districts where they can see each other's work and know each other's results.

IN VICTORIA.

In the colony of Victoria there are a number of mines in the outlying districts to which the above remarks also apply. On the larger goldfields, such as Bendigo and Ballarat, the gold is usually very coarse and easily caught, so that the chief difficulties occur and the most skill is required in the mining department. Therefore the management is naturally entrusted to an intelligent, practical miner, and the milling does not receive the special expert attention which is required when dealing with very fine gold. The batteries are almost always built in the colony, and as the results are satisfactory to both makers and purchasers, it is perhaps scarcely wise for an outsider to offer any adverse criticism. It has to be remembered also in comparing the output with that obtained in other countries, that practically the whole of the material crushed consists of fairly hard quartz. Still, it seems likely that by adopting a heavier type of stamp, and by substituting woven wire screens for punched plates, fewer stamps would be required for an equal amount of ore.

In the Kalgoorlie district of Western Australia the conditions are so unique that a comparison of results with other places can scarcely be made. On the one hand the gold is so finely divided that the output has been limited by the absolute necessity for very fine crushing, while on the other hand the comparative softness of the ore has, of course, tended to increase the stamp duty.

LOW STAMP DUTY IN NEW ZEALAND.

As regards New Zealand, the following reasons sufficiently explain the very low stamp duty on the principal goldfield at the present time, namely, the Hauraki district. In the first place, the ore is exceptionally tough; secondly, the gold is finely divided, and, therefore, fine crushing is required; and, thirdly, as the whole of it is treated by cyanide, it is either crushed dry or with very limited quantities of water, so that the pulp is very thick.

SOUTH AFRICA OUTSTRIPS THE UNITED STATES.

As America was certainly the home of first-class milling practice, which was transplanted to the Witwatersrand largely by American engineers, it appears strange, at first sight, that South Africa should have outstripped the United States. The whole reason for this lies in the extent and in the consistency and regularity of the gold-bearing reefs, which enabled development to be carried on with a precision and certainty which have never been possible in any other country. With few exceptions, the mills were backed up, and, so to speak, oppressed by large and constantly increasing ore reserves in the mines, and as depth was attained the ore became harder, so that, unless the mills had kept pace with the mines, the total output would have gradually decreased. Here, then, were all the conditions necessary for that practical form of evolution known as the survival of the fittest, and the struggle applied both to mills and millmen. Mills which in some parts of the world would have been considered as models of perfection, were ruthlessly, but correctly, sacrificed and superseded by designs more adequate to the task imposed upon them.

The above brief glance at the principal conditions which modify the milling practice on a few of the more important goldfields of the world, shows that no fair and adequate criticism is possible without carefully considering, in detail, a number of conditions which affect the final result in each particular case. Those points which bear upon the quantity of material crushed will first be dealt with, and afterwards those connected with the recovery of the gold.

THE NATURE OF THE ORE.

From a crushing point of view ores may be roughly classified in the following manner:—

Soft, such as the silicates of alumina and magnesia.

Friable, such as the upper and completely oxidised portions of heavily mineralised lodes.

Hard and brittle, as the semi-translucent quartz met with so often in all parts of the world.

Hard and tough, as chalcedonic quartz, quartzite, and the like.

Hardness can be defined and measured on the ordinary scale used by mineralogists. Toughness is a more elusive quality; but anyone accustomed to break up samples of many kinds of ore can achieve both definition and measurement with a hand hammer. A tough ore is one that rebounds after a blow, and is reduced in size by *attrition* rather than by *cracking*, except under a very massive blow.

SCREENS.

Over the greater part of Australia punched plates are largely used, but in South Africa woven wire screens are almost universally employed. The great advantage of the latter is that for equal sized holes they have a greater discharge area than the plates, but their disadvantage is the necessity for more frequent renewal owing to breakage. This, however, is a small matter compared with their greater capacity, and as only the lower part of the screen is really effective for discharge, the cost of renewals can be reduced to a minimum by using shallow screens, or, as is sometimes done, by turning the screen upside down when the lower part is worn.

The size of the holes in the screen depends not only upon the condition in which the gold occurs in the ore, but also upon the methods of extraction which are to follow the crushing process. For instance, when amalgamation only is to be employed in recovering the gold, it is necessary to break the gangue to such a fineness that the particles of gold are absolutely *detached* from the stone. But when the amalgamation process is to be followed by any method of bringing the gold into solution, it is sufficient to *expose* the said particles without necessarily detaching them. Hence on the Rand, where cyanide treatment is invariably applied to the mill tailings, there has been a steady tendency towards coarser screens, always with the one object to increase the output of the mill, and thus lessen the cost of crushing per ton, so far as this can be done without lessening the total extraction. In the early days, 1,600-mesh screens were the rule, then 900-mesh. Now 700- or 600-mesh is common, and even 400-mesh is sometimes used. The increase in output caused by the change from 900- to 700-mesh in that district amounted to about 10 per cent. And the tailings residues to-day are certainly lower than they were nine or ten years ago, but that, of course, is due to improvements in the cyaniding. Still, allowing for this improvement, the results conclusively show that even with very finely divided gold very coarse crushing is not incompatible with good extraction.

SPEED OF STAMPS.

It is clear that there is an absolute limit to the speed at which gravitation stamps can be run, which is determined by natural laws; for if the drop be not completed before the cam gets in the way, the stamp tappet will fall on the cam instead of the head upon the ore. If the stamp be considered theoretically as a freely falling body, the time required for, say, a 9-in. drop will be 0·215 second. Allowing an equal time for the lift, and no loss of time between the two, the maximum speed attainable in theory with a 9-in. drop will be 139½ drops per minute. But the stamp does not fall with perfect freedom, because there is the friction of the guide blocks to be taken into account, neither would it be possible practically to run with no interval of time between the completion of one drop and the commencement of the next lift.

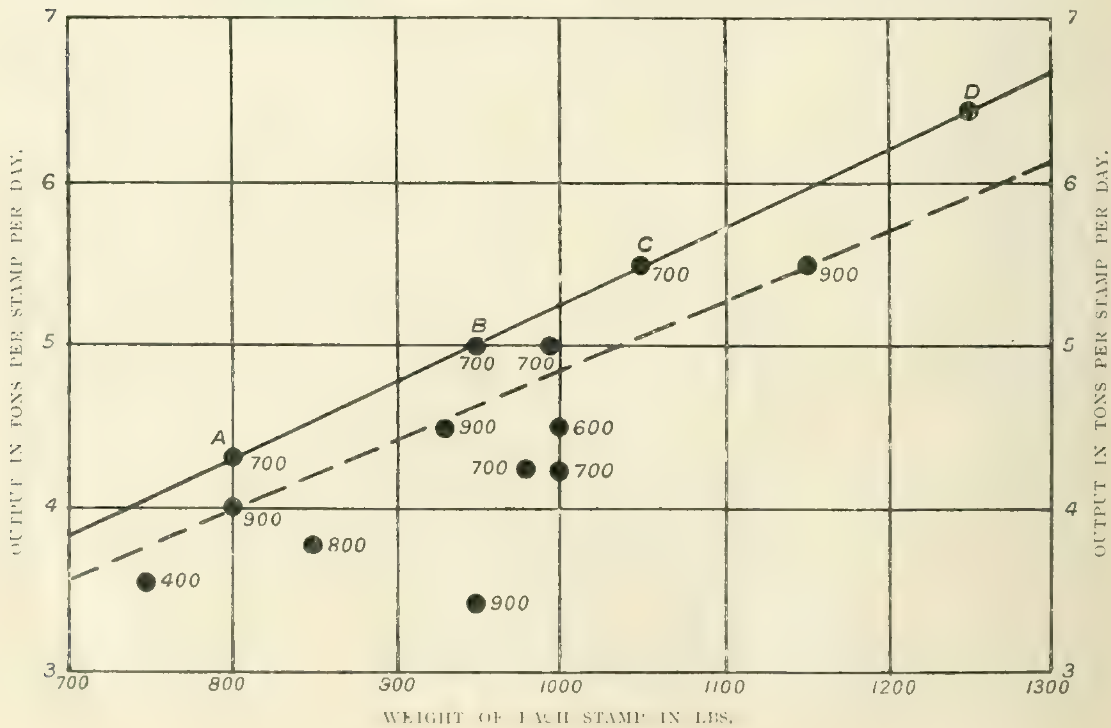
Therefore it is evident that nothing approaching the result figured out above can be expected in practice; and the speed of about 95 drops per minute with a fall of between 8 in. and 9 in. now attained is not likely to be exceeded with stamps of the ordinary gravitation type. Rapid running stamps have been designed, provided with springs which are compressed during the lift of the stamp stem, and when released by the cam these springs accelerate the speed at which the stamp falls, and thereby allow it to be run at a greater number of drops per minute. Also by substituting parallel motion links in place of the present guide blocks, some increase of speed might be obtained, but as the simplicity of the machine is diminished by the addition of either springs or links, no real practical advantage is likely to result from such modifications in the design. Accepting, therefore, a speed of 95 drops at 9 in., or 100 drops at 6 in., as the practical limits of speed allowed by the mechanical conditions of the problem, it seems to be clear from the milling point of view that all stamps should be run at this speed, or as near to it as their condition of repair will allow; for to run at less than the maximum speed is, so far as crushing is concerned, almost exactly equivalent in its results to stopping the mill altogether during a portion of each day. Whether any improvement in the amalgamation is effected by slow running is a question to be dealt with later on.

WEIGHT OF STAMPS.

Having reached the practical limit of speed, the next direction in which the millman will naturally turn to enlarge the output from his battery is towards heavier stamps. On the Witwatersrand the gradual but continual increase in the weight of the stamps has shown conclusively that on the class of ore there prevalent each increment of weight up to the present limit of 1,250 lbs. has resulted in an increase of output. It may be objected to this view that the use of screens of coarser mesh has contributed to the result, and this is, no doubt, true to some extent, but a reference to the points lettered A, B, and C in the diagram below will show the result of increased weight in three cases where the screens were of equal mesh. It has to be remembered also that the pyritic ore now being crushed with the heavy stamps is very much harder than the oxidised ore that was dealt with some years ago, when the lighter stamps were in vogue. While this shows that the increase of stamping power has been actually greater than is indicated by the figures plotted on the diagram or tabulated below, it must not be taken for granted that an equal advantage can be obtained in the same way when crushing soft or friable ores, neither is it safe to assume that there is no limit to the increase of output which is obtainable in this manner.

In order to exhibit actual results in a form in which they may be readily compared, the annexed diagram has been plotted from a number

DIAGRAM SHOWING BETWEEN WEIGHT OF STAMPS AND THEIR OUTPUT.



of published returns * relating to various mines at Johannesburg. The weights of the stamps are plotted as abscissæ and the corresponding outputs as ordinates.

The outputs were all adjusted to a uniform speed of 95 drops per minute, and the height of drop only varied from 7½ in. to 8½ in. The size of the screen mesh, where known, is indicated by the numbers placed alongside the black circles. As might have been expected, there is a considerable variation even in cases where the conditions are apparently similar, but the most striking and unexpected circumstance is that the four highest results, A, B, C, and D, fall into an absolutely straight line. Considering that the irregularities exhibited are probably due to imperfect feeding and other matters which would all tend to diminish the output, it seems quite reasonable to conclude that this straight line fairly represents the maximum output (for that class of ore) which can be maintained in actual work on a large scale and over a long period with 700-mesh screens. The numbers in the following tables were obtained by measurement from the same diagram plotted on squared paper. The dotted line shows the probable maximum output obtainable with 900-mesh screens :—

TABLE I.

Weight of Stamp in lbs.	Tons crushed per Stamp per day.		Weight of Stamp in lbs.	Tons crushed per stamp per day.	
	700-mesh.	900-mesh.		700-mesh.	900-mesh.
700	3·85	3·60	1,000	5·27	4·85
750	4·08	3·80	1,050	5·50	5·06
800	4·32	4·01	1,100	5·74	5·27
850	4·55	4·22	1,150	5·97	5·48
900	4·79	4·43	1,200	6·21	5·69
950	5·02	4·64	1,250	6·44	5·90

Output of Witwatersrand batteries according to weight of stamps. At 95 drops per minute, about 8-in. drop, and 4-in. to 6-in. height of discharge.

An inspection of the above table shows that an increase of 100 lbs. in the weight of the stamp has about the same effect upon the output as the change from 900 to 700-mesh. For instance, taking the 1,050 lbs. stamp, the change of screens makes a difference of 0·44 ton per day, while an increase of weight to 1,150 lbs. makes a difference of 0·42 ton with the finer screen, and of 0·47 ton with the coarser screen.

FEEDING.

This is a most important matter as regards the output of a battery. The essential principle of proper feeding may be expressed paradoxically by saying that the more slowly the material is put in the more quickly it comes out, or, in other words, by keeping only a very thin layer of ore on the dies the stone is more readily broken. A little consideration makes this quite clear, for if the stamp falls on a piece of rock which itself lies directly upon the die, the piece receives the whole force of the impact. On the other hand, if the piece receiving the blow is embedded among a number of other pieces which form a thick layer over the die, the downward motion is gradually instead of suddenly arrested, as it squeezes together the layer of loose pieces, and only a portion of the effect is available to crack them. And, of course, the effective height of fall is also less when there is a lot of ore above the dies. The writer had these truths forcibly impressed upon him many years ago, when running a small hand-fed battery with a Boer feeder. This man soon discovered that by throwing in a lot of stuff at one time, he could then sit down for half an hour while the choked-up battery gradually cleared itself. The obvious and successful remedy was the substitution of a less intelligent but more industrious Kaffir.

Now, it is evident that as the feed should be kept low, it must of necessity be very regular,

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* [illegible] "The Gold Mines of the Rand," Hatch and Chalmers, 1895, p. 262.

in order to prevent actual contact at any time between the shoes and the dies. In this respect hand-feeding properly done is quite perfect and superior to automatic feeding, but the amount of attention required for the former, and the consequent cost, turn the balance in favour of automatic feeders, which also give excellent results. That is to say, the feeding is so regular that it can be adjusted to give a very low feed without causing undue breakages. Consequently in all mills, large and small, where a high stamp duty and low costs are required, automatic feeders are provided.

The output of a battery also depends to some extent upon the size to which the ore is broken before it reaches the boxes. It is evident that previous breaking reduces the work required of the stamps; but as it takes fewer blows to break up the larger pieces than it does to crush the whole to the size of the screen holes, it is also clear that there must be a practical limit somewhere beyond which the preliminary breaking should not go. Mr. T. K. Rose* puts this limit at ½ in. cubes, but 2 in. to 2½ in. is far more common practice where rock breakers are used. There seems little to choose between the two types of rock breaker principally in use, namely the reciprocating jaw breaker and the rotary machine, the principal point being that the apparatus of either type should be one that is turned out by experienced makers. In Australia the Blake machine seems to be the favourite, in Johannesburg the Blake or the Gates is generally used, and in America the Gates and the Dodge breakers are largely employed.

DISCHARGE OF PULP.

The discharge from the mortar boxes is effected to a small extent by the continual flow of water through the boxes, but the principal agent in the ejection of the crushed rock is the splashing caused by the fall of the stamps. As each stamp descends, it splashes the pulp in all directions and to a limited height according to the weight and drop. As the only part of the splash which assists the discharge is the part which strikes the screen, it is evident that if the lower edge of the screen is very much higher than the tops of the dies, so that a large portion of the splashed pulp strikes the solid front of the mortar box below the screen, the conditions are unfavourable for a rapid discharge. When, therefore, the main object is to keep the ore in the boxes for a considerable time with a view to inside amalgamation, deep mortar boxes with a high discharge are used. Before the development of cyaniding and pyritic smelting, this was the usual and successful practice in districts where amalgamation had to be relied upon alone for the extraction of ores containing minerals which tended to sicken the quicksilver and retard amalgamation. Nowadays, however, the practice is rather to crush such ores coarsely and rapidly, and to rely upon other methods, such as concentration followed by smelting, or direct cyaniding, for the recovery of that part of the gold which is not readily amalgamated. Therefore low discharge is one of the features of modern milling in most countries where proper attention has been given to the subject. On the Rand very low discharge is the rule, even down to 2½ in. in some cases. The wear and tear of the screens is increased because they are battered by a larger proportion of coarse pieces when they are low, and therefore it is not advisable to place them lower than is necessary to discharge the ore just as fast as it is crushed to the requisite size. So far as one may judge from a comparison of results which are, however, affected by other variable conditions, it appears that there is nothing gained by reducing the height below the following figures for hard quartz ore or banket:—

With 400-mesh screens ...	2½ in.
,, 700 ,, ,, ...	4 ,,
,, 900 ,, ,, ...	5 ,,

CONTINUITY OF WORK.

Having secured the maximum efficiency of the stamps during the time they are working, it is also equally important that the work shall not be impeded by accidental stoppages. A series of interruptions caused by breakages or the like costs much more than a complete stoppage for repairs at regular and suitable times, because in the first case all the mill labour has to be paid for during the time the battery is idle, but only a small part of it in the second case. The following are the principal conditions by which is secured that continuity of operations which is characteristic of the best milling practice at the present day.

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* "The Metallurgy of Gold," [illegible] p. 10[illegible].

1. Sound construction in every detail when the mill is erected, and a liberal allowance of steam power.
2. Constant maintenance of battery and engine in good repair.
3. The provision of convenient means of access to every part of the machinery.
4. An overhead travelling hoist for the rapid replacement of wearing parts.
5. A sufficient and efficient staff.
6. Plenty of storage capacity in the ore bins to provide against irregularity in the delivery from the mine.

The first three of these conditions really have to do with the design and construction of mills, which is beyond the scope of the present article; but the last two may be briefly discussed.

STAFF.

In mills of good design with full equipment, including automatic feeders and well-arranged with respect to accessibility, the following number of men should be sufficient for the various sizes, where white labour is employed :—

For 10 stamps—one man and one boy per shift.

For 25 stamps—one amalgamator and one engine-driver for each shift.

For 50 stamps—one amalgamator, one assistant ditto, one engine-driver, one stoker per shift.

For mills of the sizes given above there is not sufficient work to keep a millman or mechanic continually employed, but for larger mills the regular staff should include two fitters and a carpenter, who may work their shifts at suitable times as required. In addition to these a 100-stamp battery should have one amalgamator with two assistants, one engine driver, and one stoker. In some cases, according to the situation and arrangement of the plant, it is necessary to employ separate attendants for some parts of the machinery, such as crushers or elevators. It is always desirable that the men who handle the amalgam or the plates should have no dirty or greasy work to do, and this is possible in large mills, where special greasers can be employed. In Johannesburg, where Kaffir labour is apparently cheap, there is no difficulty about extra labour of this kind, but in small mills where native labour is not available, the amalgamators have to do all the work around the mill, and every facility should be provided to induce cleanliness in dealing with the mercury and amalgam.

ORE BINS.

As the considerations which govern the storage capacity of a mill illustrate the method of deciding many points of metallurgical practice, it may be worth while to go into the question somewhat in detail at the risk of being tedious. If the bins are too small, any irregularity in the output of the mine immediately interrupts the crushing. If too large, there is a loss consisting of interest and redemption on the extra cost of constructing them, and interest on the cost of raising the extra ore lying in the bins. Of course, no account need be taken of the gold in the extra ore, because if it were not in the mill it would remain equally unavailable in the mine. Take the case of a 50-stamp mill crushing 300 tons per day, and assume the following costs: For stoping, raising and tramming ore, say, 12s. per ton, which is equal to £180 for each 300 tons. The interest on this at 5 per cent. per annum amounts to 0·021 pence per ton crushed per annum. Cost of extra bin capacity for 300 tons, say, £100. The interest on this with its redemption in, say, ten years, amounts to 0·027 pence per ton. The additional storage, therefore, means an increase of 0·048 pence per ton to the cost of crushing. Now against this may be placed the loss due to one day's stoppage of the mill. Assuming that the total yield per ton of ore is 9 dwts., the output is lessened by £540, on which the interest amounts to 0·062 pence per ton on the yearly output of, say, 105,000 tons. Then there is a partial loss of wages on all the surface work, and the extra cost of stopping and re-starting the various operations, which may be put down at not less than £30, and which works out at 0·008 pence per ton. The result is that stopping the mill for a single day costs 0·07 pence per ton, while the provision of an extra day's storage costs only 0·048 pence per ton. If the shortage of ore occurs several times in a year, the balance in favour of a large bin capacity is still more pronounced. The saving of one day's interest on the cost of the battery might also fairly be added to the credit side of the account, and it is not surprising, therefore, to find that much larger bins are provided in modern mills than was customary a few years ago. Formerly, one day's supply was considered sufficient, whereas now as much as three days' supply is provided for.

WEAR AND TEAR.

Some interesting experiments on the actual wear of shoes and dies of various materials were made at the mill of the Robinson Company in Johannesburg many years ago,* which are, however, still of value, as there has been practically no advance in this direction since that time. The best results showed that the shoes diminished in weight at the rate of 4½ ozs., and the dies at 2½ ozs. per ton of ore crushed, or 7 ozs. altogether. In 1900, at the Haile mine†, the wear of shoes and dies together was 0·5 lb. per ton, which is almost identical with the best Robinson figure. But as there is at present no unanimity of opinion as to the best material, the average of the Robinson Company's experiments, as given below, will more nearly represent the wear in general practice :—

Average weight of shoe when put in	171 lbs.
,, ,, taken out	44 lbs.
Actual loss of weight in working	127 lbs.

Tons crushed, 379.

Therefore the average wear of the shoe is 0·335 lb. per ton. But there is also the 44 lbs. of material discarded, which has also to be debited to the cost of crushing, and which works out at 0·116 lb. per ton of ore. The following figures relate to the dies :—

Average weight of die when put in	119 lbs.
,, ,, taken out	51 lbs.
Loss by attrition in working	68 lbs.

Tons crushed, 347.

Therefore the loss by attrition = 0·147 lb. and by waste 0·196 lb.

Adding these four figures together, the average total loss of shoes and dies is 0·794 lb. of steel for each ton of ore crushed.

The usual materials may be placed in the following order as regards durability, the most durable being placed first : Chrome steel, manganese steel, Bessemer steel, forged steel, iron.

If the matter were merely one of the cost of material it could be easily settled by comparing the total wear multiplied by the cost per lb. of each material, but the time occupied in replacing the worn-out shoes and dies has also to be taken into account, and for a maximum output the most durable material would be chosen, unless, of course, its price should be prohibitive. There are also a number of other parts in a battery which require renewal, the chief of these being stems, tappets, cams, and bearings, which, however, do not amount to much per ton of ore.

EXPENDITURE OF POWER.

In driving a mill the greater part of the work is done in lifting the dead weight of the stamps, and this can be readily calculated for any given case. Thus for each 1,000 lbs. stamp at 90 drops per minute, with an 8-in. drop, 1·82 h.p. is required theoretically. But the friction of guide blocks, cams and bearings adds generally about 10·63 h.p. to this calculated quantity, so that the real amount required is 2·45 h.p. per stamp. Similarly a 1,250 lbs. stamp with an 8-in. fall at 95 drops per minute will actually require about 3¼ h.p. per stamp. The total power required for a 100-head mill of the heaviest type now in use may be summed up as follows :—

Stamps, 100 at 3¼ h.p. ...	325 h.p.
Rock breakers, say 25 tons per hour ...	30 ,,
Sundries, say	15 ,,
Total power required...	370 h.p.

This approximate estimate shows the importance of the fuel consumption, and explains why with the erection of large and heavy mills so much more attention is given to the type of engine selected. Whereas formerly a single-cylinder high pressure engine was considered good enough, the practice on the Rand at the present time is to provide compound condensing engines, with surface condensers. And while coal remains at 20s. per ton there is every inducement to engineers to introduce all apparatus which may tend to economy in the consumption of fuel. In Australia for many years firewood was so plentiful that little attention was paid to this matter, but lately the supply of firewood has become exhausted in the immediate neighbourhood of the older goldfields, and it has to be carried constantly increasing distances, so that the price is steadily rising, and the question of economical engines will probably receive more attention from mining men.

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* *South African Mining Journal*, [illegible] December, [illegible]

† Mineral Industry, [illegible]

Milling and Amalgamating.

ORE SORTING.

So far all the points considered have related either to increase of tonnage or decrease of cost, but anything tending to enlarge the output of gold or increase the profit is equally important, and therefore the question of ore sorting essentially belongs to the milling problem.

The process of selection, of course, begins in the mine, and is of necessity carried out in every mine to a greater or less extent. If the sampling and assaying are systematically carried on during development, the average value of each block of ore opened up should be fairly well ascertained by the time it is prepared for stoping. And, as a matter of course, everything which will not pay for raising and treating should be left behind, and the payable portions only should be taken out, so far as this is consistent with the methods of working. But when the broken ore is brought to the surface, there is generally some country rock mixed with it, and very often it contains many lumps of ore which, if taken separately, will not pay for the subsequent processes. The problem, then, to be considered is whether it is profitable to sort out the less valuable pieces before milling, and to what extent this should be done.

For the purpose of this discussion, the bulk of the broken ore may be divided into three classes in the following manner :—

1. Ore which is undoubtedly payable and about which nothing further need be said.
2. Ore which will pay for all current charges, such as costs of labour and material actually incurred in its treatment, but not for the whole of the fixed charges, such as redemption, etc.
3. Ore which will only pay for part of the actual treatment costs.

The inclusion of the second class in the supply to the mill is correct, because if it contributes anything towards the fixed charges it relieves the rest of the material from part of such charges, and causes a real increase in the total profit from the mine on its whole life; although, of course, a larger temporary profit might be made by its exclusion. And this line of reasoning appears to offer a basis for genuine distinction between what is called "picking the eyes out of a mine" and the legitimate selection and sorting of the ore—namely, that anything which is done to increase the profits for a time at the expense of net total profit comes within the meaning of the phrase above quoted, and is essentially bad policy. In estimating the total profit of a mine, due consideration must be given, not only to the interest on capital sunk in development and other matters, but also to the earning power of the gold itself when extracted. On the Witwatersrand, where the mines have to such a great extent been controlled by men of great financial ability, these considerations have been fully weighed, and the result, as shown below in Table II., is that surface-sorting has been very properly adopted in many mines in that district.

To return from this digression to the third class of ore given above, the main point which determines its inclusion or rejection is whether the actual loss in current expenses caused by its treatment is less or more than the cost of picking it out.

To make this quite clear, the following example is given, in which the figures represent the actual costs on the Rand of the various items concerned in the problem :—

	s.	d.
Rock-breaking, per ton... ...	0	4
Transport to mill .	0	4
Milling	2	9
Cyaniding (all material) ...	2	10
	6	3
Fixed charges per ton . . .	1	6
	7	9

Cost of sorting per ton of ore rejected, 2s. 6d.

Then, according to the reasoning already given, class I. will include all ore which yields more than 7s. 9d. per ton. Allowing for a total extraction of 88 per cent. from the best ore, everything over the value of 2·2 dwts. per ton belongs to the first class.

Calculating in the same way, but allowing only 80 per cent. extraction on lower grade material, all ore over 1·95 dwts. belongs to the second class.

Dealing now with the third, or doubtful, class, and allowing only 70 per cent. extraction from this lowest grade, the limiting value between inclusion and rejection may be arrived at thus :—

If treated, it costs ...	6s. 3d.	per ton.
If wasted, it costs ...	2s. 6d.	„

Therefore net cost of treatment is 3s. 9d.

As ore containing 1·34 dwts. will at 70 per cent. extraction give a yield of 3s. 9d. per ton, it follows that it is profitable to sort out all material below this value and to retain all above it, under the conditions which have been assumed.

To avoid misconception, it is necessary to point out that in the selection of ore in the mine before stoping a much higher grade than this would be left in place, because then the cost of raising and tramming would be included in the current working costs. The above figures only relate to surface sorting.

THE PRACTICE OF SORTING.

Turning now from the economic to the practical side of the matter, it is evident that sorting can only be introduced when there is some readily visible difference between the richer and poorer pieces of ore. It is especially easy when the gold is so intimately associated with some definite mineral in the ore that the value of the stone can be directly inferred from the quantity of that particular mineral which is present in each piece. On the Rand the banket conglomerate is the valuable material, and this can be easily distinguished from pieces of the country rock when the ore is washed on the sorting table.

The sorting is usually effected by passing the ore as raised from the mine on to a travelling belt or a revolving circular table, where a jet of water plays upon it. The sorters stand alongside the table, and pick the pieces of waste rock from the continual stream of mixed material which is carried slowly past them. The ore remaining upon the belt or table, after it has passed the sorters, is delivered to the rock breakers. A table, 25 ft. in diameter, with an annular sorting rim not exceeding 2 ft. 3 in. in width, is suitable when the sorters stand at the outside edge only, as is the case when the apparatus is driven from a central vertical shaft. This size is sufficient for sorting out about 20 per cent. of waste from, say, 700 tons of ore daily. The cost with Kaffir labour and white supervision amounts to about fourpence per ton of ore mined, so that if 20 per cent. of the total is sent to waste, the cost works out at fivepence per ton calculated on the quantity milled, or at 1s. 8d. reckoned on the tonnage sent to the waste dump. At 16 per cent. of waste the figures will approximate to 4·76 pence and 2s. 1d. respectively. The degree to which sorting has been applied may be realised from the following table, which has been compiled partly from the annual reports of Mining Companies, and partly from data in the condensed reports published in the *South African Mining Journal*:—

Name of Mine.	Period over which average is taken.	Year.	Tons mined and hoisted.	Tons after sorting.	Percentage sent to waste dump.
Ferreira...	3 months	1896	42,141	28,911	31·39
Meyer and Charlton ..	... 10 ,,	1897	111,000	80,753	12·14
New Heriot ..	... 7 ,,	1897	86,171	64,290	25·51
Ferreira	6 ,,	1897	92,022	62,419	32·17
Crown Reef ...	... 12 ,,	1897-8	221,543	185,179	16·41
,, ,,	... 12 ,,	1898-9	239,413	202,456	15·53
Lancaster West	.. 5 ,,	1899	34,770	31,730	8·74
Robinson ..	6½ ,, ..	1899	223,008	165,035	26·00

TABLE II.—Showing some variations with regard to the sorting of ore before milling as practised on the Witwatersrand goldfields.

As some of the Johannesburg companies have not adopted sorting, the total variation is from 32 per cent. to zero; and doubtless some of the differences are due to the varying thicknesses of the reef and to the value of the ore. But it would be interesting to know how much of the variation is to be attributed to these causes, how much to differences in the relation between working costs and fixed charges, and also how much is due to the personal opinions of the several managers upon the question of sorting.

(To be continued.)

STANDING CHARGES.

BY

CLAUDE W. HILL, Assoc.M.Inst.C.E., M.I.E.E.

A PROPERLY arranged system of manufacturing and trading accounts, in addition to showing net profits, should serve two purposes; first, it should provide figures upon which a correct judgment can be formed, in preparing estimates, as to the amount to be added to the bare cost of material and labour to cover standing charges; and, secondly, it should, by giving the items in detail, show in what direction economy may be sought.

Standing charges may be conveniently divided into two classes—External Expenditure, such as advertising, railway carriage, coal, etc., for which invoices are received from outside, and which are comparatively simple to deal with; and Internal Expenditure, such as repairs and maintenance, shop expenses, pattern work, etc., which are rather more difficult to deal with.

EXTERNAL EXPENDITURE.

Each morning, when the letters are opened, the invoices are placed in heaps and handed to the invoice clerk. He stamps each with the stamp (Form No. 29), and gives it a consecutive number, which he, at the same time, enters in the Invoice Guard Book (Form No. 74).

INVOICE GUARD BOOK.

Form No. 74.

No.	[illegible]	General Purchases	Advt. Circulars and Catalogues	Carriage	Rents Rates and Taxes	Books and Stationery	Fees and Patent Fees	Insurance	Unfinished Material	Capital Account	Repairs Account			Total
	Brought forward...													
	Carried forward.													

STAMP FOR INVOICES.

Form No. [illegible]

No. ....
Received ....
[illegible]
Standing Order
[illegible] Order No.
[illegible]
Capital Account ....
Repairs and Maint. Account
Stock Ledger
Cost Ledger
Packing Dept.

The invoices then go to the storekeeper to be checked against the goods, and on their return to the invoice clerk are folded up and pasted in the Guard Book, their amounts being entered in the columns to which they relate. Thus, if the goods are for manufacturing purposes, they will be entered under "General Purchases" or "Unbooked Material," while, if they form an item of standing charge, they will be entered under that particular heading.

It will be noted also that columns are provided for the amount of goods purchased for capital account and for repairs and maintenance.

If it is considered inadvisable that all the items of standing charge should be known to the general staff, those which it is thought desirable to keep private, such as law charges, patent royalties, etc., may be posted in a separate private Guard Book.

In addition to items for which invoices are received, cash payments have frequently to be made, and for these columns should be provided in the Cash Book similar to those in the Guard Book. The Guard Book and Cash Book columns are totalled every month and carried forward to Standing Charges (Form No. 79).

INTERNAL EXPENDITURE.

For the determination of internal expenditure standing order numbers which have the prefix S.H., to distinguish them, are given to each part of the buildings, such as S.H. 1, foundations and walls; S.H. 2, drains and sanitary work; S.H. 3, roofs, and so on; and to the plant, as S.H. 21, power plant; S.H. 22, line shafts, pulleys and bearings; S.H. 23, belting, and so on.

There are also standing numbers for labouring: such as S.H. 101, sweeping and cleaning up shop; S.H. 102, assisting fitters; S.H. 103, working crane.

All material supplied out of stores, and all labour executed on buildings or plant, is booked in the usual way in the Stores Day Books and Time Cards respectively, and from them to the Buildings Account or Plant Account Cards (Form No. 68).

For each order number two accounts are kept, one being headed "Capital Account," and the other "Repairs and Maintenance"; and, in order that they may be distinguished easily, they are kept on cards of different colour—say blue for capital account, and buff for repairs.

In order to prevent reckless expenditure, each foreman should enter on a weekly

BUILDINGS, PLANT, &c., ACCOUNT.

Form No. 68.
Capital account on blue cards.
Repairs account on buff cards.
Total [illegible] on White cards.

		External Purchases.				Internal Expenditure.						
Date.	Description.	G. B.	£	s.	d.	P. C.	Materials.			Labour.		
							£	s.	d.	£	s.	d.

Requisition Note (Form No. 53) whatever additions, repairs, or renewals he requires for the buildings or plant under his charge.

When authorising the different items, the manager marks on the note whether the cost shall be booked to capital or repairs, being guided by the principle that expenditure which increases dividend-earning capacity shall be booked to capital and all other to repairs.

drawer, being distinguished from the others by being white. The totals from these again are posted to the Standing Charges Account (Form No. 79).

The "general labouring" items are posted from the Time Cards into "General Labouring," the columns of which are totalled and carried forward into standing charges each month.

PLANT REQUISITION NOTE.

Form No. 53.

The Requisition Note is for additions [illegible] morning.

All additions, repairs, and renewals must be entered on the Requisition Note. Urgent repairs must be executed at once, but all others must wait the authorisation of the Manager.

For	Description.	Addition, Repair, or Renewal.	Quantity.	Probable Cost.	Date.	Authorised.			Remarks.
						Order No.	Date.	Signed.	

In addition to the items posted from the Stores Day Book and Time Cards, the items from the "capital" and "repairs" columns in the Guard Book and Cash Book must also be posted to the buildings and plant accounts.

Each month the buildings and plant repairs are carried forward into a summary, the rulings of which are the same as Form No. 68, and which may be kept at the back end of the card

MANUFACTURING ACCOUNTS.

(NOT PUBLISHED.)

MATERIALS.

BOOKED MATERIALS—	
Stock at last stock taking, including cost of material in finished stores and work in hand ..	£35,000
General Purchases	[illegible]
	[illegible]
Present Stock, including cost of material in finished stores and work in hand ..	£32,000
	£68,000

STANDING CHARGES.

Form No. 79.

Ref.	Description.	January.						February.						March.					
		Items.			Totals.			Items.			Totals.			Items.			Totals		
		£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.

[illegible]			[illegible]
[illegible]			[illegible]
[illegible]			[illegible]
[illegible]			[illegible]
[illegible]			
	Capital	Repairs	
Buildings	[illegible]	[illegible]	[illegible]
Plant	[illegible]	[illegible]	[illegible]
Patterns	[illegible]	[illegible]	[illegible]
Packing cases	[illegible]	[illegible]	[illegible] [illegible]
	[illegible]	[illegible]	Discrepancy [illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
	[illegible]
Present Stock	2,2[illegible]
Material [illegible] .	[illegible]
Booked Material	[illegible]
Unbooked [illegible]	5,3[illegible]
Discrepancy	5[illegible]
	£65,357

In estimating the percentage to be added to net cost of material—

$\left(\frac{65{,}357}{[illegible]}-1\right)\times 100 = 9$ per cent.

Labour [illegible] booked [illegible] orders ..	£37,5[illegible]
Standing charges as taken from published [illegible]	[illegible]
	£75,5[illegible]

In estimating the percentage to be added to net cost of labour—

$\left(\frac{75{,}500}{[illegible]}-1\right)\times 100 = 101\cdot 5$ per cent.

LABOUR.

Finished Stock Account—

Cost of labour on finished stock at last stock-taking, including stock orders in hand	£7,000
Cost of labour on stock orders completed (from Prime Cost Book)	10,000
	£17,000
Cost of labour on present stock, including stock orders in hand	£6,500
Booked out ..	£1[illegible]

Labour Account—

Total labour on customers' orders			£37,500
Less cost of labour on work taken from finished stock			10,500
			£27,000
Labour booked on stock orders			10,000
Labour booked to orders in hand			4,000
Labour on shop work—	Capital	Repairs	
Buildings .	[illegible]	[illegible]	[illegible]
Plant ..	[illegible]	[illegible]	[illegible]
Patterns ..	[illegible]	[illegible]	[illegible]
Packing cases	250	93	343
	[illegible]	[illegible]	
[illegible]			2,500
			£44,[illegible]

This total agrees with the totals of the Wage Book and Cash Book.

Repairs and Maintenance Account—

		Material	Labour
Buildings.	Direct purchases (from Guard Book)	£ 80	£ —
[illegible]	Shop work (from Prime Costs)	[illegible]	[illegible]
Plant.	Direct purchases	[illegible]	—
	Shop work .. .	2[illegible]	17[illegible]
Patterns.	Direct purchases ..	—	—
	Shop work	[illegible]	2[illegible]
Packing cases.	Direct purchases	—	—
	Shop work	4	[illegible]
		£7[illegible]	[illegible]

Material .	£7[illegible]
Labour	[illegible]
	£1,200

GROSS PROFIT.

Expenditure.	£	Income.	£
Labour booked to customers' orders completed .	3[illegible]	Sales	[illegible]
Material ditto ..	[illegible]		
Gross profit ..	[illegible]		
	£[illegible]		£158,857

PROFIT AND LOSS ACCOUNT.

(FOR PUBLICATION.)

Expenditure.	£	Income.	£
Salaries of office and works, interest on loans, rates, rents, taxes, &c. (all taken from their various books and specified in detail)	29,800	Gross Manufacturing Profits	56,000
Repairs and maintenance	1,200	(Any other income, such as pupils' fees, rents from sub-tenants, &c., would be entered here.)	
Depreciation of buildings and plant .	8,000		
Net profit	17,000		
	£56,000		£56,000

PATTERNS.

The writer considers that the best way to deal with patterns is to book all new patterns to capital account, writing off depreciation at each stock-taking to an extent depending on the class of work being done.

For each size of machine (or engine, etc., as the case may be) manufactured, a separate pattern account is kept, the ruling of which is the same as Form No. 68, two accounts being kept on cards of different colours, one for capital and the other for repairs and renewals, the system being the same as for buildings and shop plant.

Packing case accounts are arranged in the same way as the pattern account, and the cases are also numbered so that they can be followed up and identified.

STANDING CHARGES, FORM NO. 79.

Reverting now to this book we see that all the items which go to make up the standing charges for one year appear on one page, and can be totalled in two directions.

Horizontally we obtain the total of each item for the year, and vertically we obtain the total of the items for each month.

PROFIT AND LOSS ACCOUNT.

In cases where the accounts have to be published, such as in that of limited companies, it is usual, in order to avoid giving away information which would be valuable to competitors, to divide this account into a "Manufacturing Account," which is kept private, and a "Profit and Loss Account," which is published.

The annexed example shows how the percentages to be added to prime cost of materials and labour are ascertained.

[illegible] see article on "Prime Cost" [illegible] July issue.

† For explanation of "unbooked material," see article on "Prime [illegible]

ENGINEERING EDUCATION IN AMERICA.

BY

FRANK HIX FAYANT.

This Article, by the Special Correspondent of a leading New York journal, sets forth from an American standpoint the advantages of a Transatlantic training for engineering students, and shows how this is to be obtained.

IF one needed proof of the value of American training for English engineering students, it would be scarcely necessary to cross the Atlantic for the purpose. But to examine the system and the methods employed it is desirable to visit some of the Eastern industrial towns of America—Pittsburg, Altoona, Cincinnati, Cleveland, Philadelphia, Schenectady or Wilmington, —where, because of their alertness of mind, young Englishmen are especially welcome.

In the works of a great American Electric Company, recently, there were four hundred graduates of the leading engineering schools of the world ; many of them, the sons of rich men, working for 1.25 dols. a day. Nearly a score of foreign countries were represented among these student workers, the British contingent being the largest. Young men from Birmingham, Manchester, Leeds, Newcastle, Sheffield and other industrial towns were there, absorbing Western ideas to be brought back to engineering establishments at home. American manufacturers welcome these young men from rival commercial nations, because they believe that, while they are training brains for foreign competitors, they are widening American markets by the diffusion of American ideas.

HOW TO START.

The young Englishman who wants the best engineering education should go to America when he leaves the public school, and enter the Freshman class of one of the engineering universities—Sibley College, Cornell University, Ithaca, New York ; the Massachusetts Institute of Technology, Boston ; the University of Michigan, Ann Arbor ; Lehigh University, South Bethlehem, Pennsylvania ; the School of Mines, Columbia University, New York ; Rensselaer Polytechnic Institute, Troy, New York ; the Sheffield Scientific School, Yale University, New Haven, Connecticut. The register of any of these institutions can be had by writing the college secretary. Among the four hundred American colleges there are scores of institutions giving more or less attention to engineering, but the seven named provide the most complete courses. Cornell and the Massachusetts Institute of Technology take first rank. The director of Sibley College is Dr. Robert H. Thurston, the Nestor of the higher engineering education in America, and one of the world's leading authorities on the steam engine. "I am from Cornell" is the open sesame to many great engineering establishments.

PRELIMINARY QUALIFICATIONS.

The "entrance requirements" of the engineering schools have reached a higher plane year by year. No young man should think of choosing an engineering career who is not fond of mathematics. To enter a freshman class in engineering the candidate must have, as part of his secondary school training, a thorough knowledge of arithmetic, elementary algebra, plane and solid geometry, plane and spherical trigonometry, and higher algebra. Too much emphasis cannot be laid on the necessity for original work in mathematical problems. The best possible preparation is furnished by English text books. No inadequately prepared student can hope to follow the pace set in American engineering schools. Dr. Thurston finds that two-thirds of the Sibley Freshmen fail to complete the four years' course. Specimen entrance examination papers may be had from any of the institutions named. It would be advisable for an English candidate to take the June examinations and then spend the summer in a university summer school preparing for the September examinations.

UNDERGRADUATE'S COURSE.

The thoroughness of the American training may be judged from an outline of the work at Cornell. The undergraduate spends four years in lecture-room, laboratory, and shop work, studying for the degree of mechanical engineer or electrical engineer, and in his upper-class years he has opportunity to specialise in the particular department he chooses for his life work—steam engineering, electrical engineering, mining engineering, railway mechanical engineering, or marine engineering. Dr. Thurston strongly urges young men to gain a broad general education before specialising. In the course of a recent interview Dr. Thurston remarked that no young man should attempt to enter the profession of engineering because it seemed to him the current fad. "To succeed, he must have natural talent for construction, natural ability in the fields of mathematical and physical science, and that vigour, pluck, endurance, and good sense, without which no man can succeed in any profession, old or new. He must have a practical as well as a theoretical imaginative side ; he will need a good general education, and a very complete and specialised professional training, including the arts as well as the sciences of his department. Above all else, if he would attain the highest success, he must be a strong man, an honest man, and a gentleman. A real engineer's novitiate in the professional school, in the office, and in the workshop furnishes the highest possible guarantee of success."

PRACTICAL INSTRUCTION.

Throughout the four years' course the engineering student works nine hours a week in the college shops, where he receives practical instruction in the use of tools and in the fundamental arts which form the basis of his afterwork in mechanical or electrical engineering. In the wood-working shop he acquires skill in the construction of patterns. These he takes later into the foundry, where he becomes adept at moulding and making castings from iron and brass. His work in the smithy, the next step in shopwork, is not complete until he has made for himself a set of tools to be used in the machine shop. Finally, in the machine shop he fashions complete machines with his own tools from castings he has made from his own patterns. While Cornell is in no sense a "technical school," and "manual training" is foreign to its aim, some of the practical work done by the students would do credit to the best engineering works. Specimens of the students' work noticed by the writer included various machine tools, a duplex pump, the pioneer "straight-line engine," and a 100-horse-power triple-expansion engine.

LABORATORY WORK.

Supplementing the instruction given in class-room and lecture-room by several score professors and assistants is the highly important work of investigation and scientific research carried on in the finely equipped laboratories. The work of the electrical engineering laboratory is known to every electrician in America, while the mechanical laboratories, possessing an equipment unequalled in any engineering works, are of inestimable value to the engineering profession. They include special laboratories for the investigation of the following subjects :—

(*a*) Strength of materials ;
(*b*) Hydraulics and hydraulic motors ;
(*c*) Friction and lubrication ;
(*d*) Transmission of power, dynamometers ;
(*e*) Steam engines, hot air and gas engines ;
(*f*) Air-compressing machinery, rock-drills ;
(*g*) Heating and ventilating machinery ;
(*h*) Elevators and mining machinery.

The new hydraulic laboratory, built against the rock wall of Fall Creek gorge, below the Sibley shops, is the most elaborately equipped building of its kind in the world. Similarly, the laboratory of strength of materials is known to the engineering profession all over America. It is equipped with a large number of the newest testing machines, ranging in capacity from 300,000 lbs. This laboratory is constantly made use of by manufacturers who desire to have materials tested, and the students benefit greatly by this practical work. Cornell students, especially seniors and graduates, are frequently asked to make tests of power and electric stations, street railways, and new machines, and no student can take his degree without having done original research of an exhaustive nature in some specialised field. Dr. Thurston tells the students that their engineering careers begin in the university, and that no student should expect to receive the University's degree who is not an engineer by experience as well as by training at the end of his course.

AN IDEAL CURRICULUM.

Dr. Thurston has several times been called by the Government as an expert on engineering education. His views on the subject of engineering curriculum are interesting and to the point :

> Educational work has no proper place in the curriculum of the professional school. That should be done, and completely, in advance. Such literature and such languages, only, fall into the scheme, properly and naturally, as contribute to the engineer's technical and professional stores. A complete line of advanced mathematics, pure and applied ; as much of the physical science of the time as constitutes a part of the fundamental basis of his professional training ; instruction and training by practice in the art of the draughtsman and in the mechanical and industrial arts ; applications of mathematics and the sciences in machine design, and in the computation of the probable efficiency and performance of the machines and apparatus of manufactures ; and, finally, the methods of determination, by experiment, with every scientific aid, of the value of such machinery in its actual use, and still higher applications of scientific method to the prosecution of original investigations of engineering problems and of research, looking to the acquirement of new and useful facts and principles in science and in every department of his work—these are the purposes and the proper field of the professional school of the engineer.

DOLLAR-A-DAY POSITIONS DURING VACATIONS.

Undergraduates are encouraged, during the long vacations, to put on working-men's garb and take dollar-a-day positions as machinists' helpers in engineering works. It is no uncommon thing to see the sons of railway presidents, ironmasters or shipbuilders, at work, begrimed with dirt and grease, alongside of moulders or machinists. The young men who are to be the future American captains of industry thus acquire practical training, and at the same time come closer into touch with the common soldiers of the industrial army.

INSPECTION TOURS.

The inspection tours to industrial centres are likewise a feature of the practical instruction. This spring, at Cornell, the writer saw forty engineering students leave for Western Pennsylvania, under the guidance of the head of the School of Railway Mechanical Engineering, who gave a continuous field lecture. The embryo engineers inspected the great electric power plant at Niagara Falls, and its dependent industries ; the blast furnaces, open-hearth furnaces, Bessemer steel works, iron and steel rolling mills, and the electric, air-brake, and engine works of the Pittsburg region ; the railway repair shops and locomotive shops of Dunkirk and Altoona ; railway roadbed construction in the mountains ; and a bituminous coal mine near the Horseshoe Curve. Managers and works superintendents were subjected to a fire of questions.

STUDENTS' COST OF LIVING.

Students at the American universities live either in college houses or in private homes in the university towns. The cost of living varies with the individual tastes of the student. Rooms and board may be had for from one to two pounds a week ; text-books and materials cost from five to ten pounds a year ; the charge for tuition varies, in different universities, from nine to forty pounds a year, the Massachusetts Institute of Technology and the Rensselaer Polytechnic Institute having a rate of 200 dols. Many Cornell students have gone through on £100 per annum. On £150 or £200 a year a young man can get along comfortably, but I do not think one American student in fifty spends £200 a year. All of the universities give scholarships and prizes, and there are many ways in which an ambitious student can cut down his expenses. The university registers all give detailed information on these points.

ACTIVE WORK AND PROSPECTS.

The four years' course completed, the engineering student plunges at once into active work, accepting any salary, however small, which will give him a foothold with an important company. A few years ago the professionally-trained young engineer had difficulty in finding employment, but now that university training has been made so intensely practical, the demand for university graduates actually exceeds the supply. Positions for suitable men are available in steel mills, electric works, locomotive shops, shipyards, power stations, etc., many producing salaries of from £250 to £500 a year, with opportunities for rapid advancement.

AN ALTERNATIVE PLAN.

Graduates of English universities or technical schools, who do not choose to take an American engineering university course, can enter the "student department" of one of the great engineering works. If, for example, the young Englishman intends to follow electrical engineering, one of the places to go to is the General Electric Company at Schenectady, New York, where there are more than 400 graduates of the world's leading engineering schools. This is one of the principal homes of the electric industry, 10,000 men being employed making electrical machinery for all parts of the world. Every summer more than 150 young university graduates enter these shops, put on "overalls" and begin work in the testing department at 12½ cents. an hour. Under the leadership of experienced electrical engineers, the students receive instruction in the various departments of the vast works.

Directly a man shows evidence of worth, his wages are increased, and opportunity is afforded him of going ahead as fast as he will push himself. Bright men are picked out, and to them are offered positions of responsibility in the works, in other shops of the company, and on outside construction work. Many of the men strike out for themselves and obtain positions with other manufacturing companies, electric power and street railway companies. If they have ability they experience no trouble in finding renumerative employment. Many of the foreign students return to introduce American ideas at home. At the works this year there were fifty men from Cornell, forty from the Massachusetts Institute of Technology, and representatives of more than a hundred other institutions, including nearly every well-known engineering school of England, France and Germany.

RAILWAY ENGINEERING.

For the student who wishes to adopt a railway career, either as a railway mechanical engineer or an operating official, the Pennsylvania Railroad offers a course of instruction for students at its great shops at Altoona. When the writer was last in Altoona there were seventeen young men taking the special course, and it is interesting to catalogue them. They were : a Japanese prince, a graduate of the Imperial University of Tokio ; an English public school boy ; two Harvard University men, one a son of the late president of the Pennsylvania Railroad, the other the son of a millionaire dock owner ; two Princeton University men, one the son of a Pennsylvania official, the other the son of a United States Senator ; four Cornell graduates, one the son of a millionaire silk maker, another the son of a railway official, the third the son of Philadelphia's leading publisher, the fourth the son of a New York lawyer ; a student of Massachusetts Institute of Technology, whose father is a Judge ; two Yale University men, one from Purdue University, and another from the University of Pennsylvania.

The Altoona course, in its entirety, extends over four years, and includes work in the erecting shop (six months), the lathe shop (six months), the vise shop (three months), the air-brake shop (two months), the blacksmith's shop (two months), the iron foundry (two months), the boiler shop (two months), the freight car and passenger coach shops (six months) with "wrecking crew" practice, the round house (four months). After the student has "fired" an engine on the road, he spends two months in the shop clerks' office, two months in the motive power clerks' office, five months in the test room, and finally three months in the drawing room. This is perhaps the most rigorous course in America. In its thoroughness it is characteristic of the management of a railway which last year showed gross earnings of £40,000,000—a system which owns enough rolling stock to fill five tracks between London and Liverpool.

ENGINEER OFFICERS IN H.M. NAVY.

BY

D. B. MORISON.

A WELL-KNOWN steamship company recently advertised for a superintendent engineer; the advertisement appeared for one week, and there were four hundred and seventy-five applicants.

In contrast with this may be cited the fact that practically continuous advertisement by the Admiralty for engineer officers, accompanied by a lowering of the standard, has for a long time past yielded such inadequate and unsatisfactory results that, unless prompt measures be taken to deal with the vital question affecting the engineering personnel, the fighting efficiency of the Fleet will be very seriously impaired.

Engineer officers in H.M. Navy are at present recruited from the following sources:—

1. The Royal Naval Engineering College at Keyham, Devonport.
2. By examination for "Direct Entry."
3. By examination for "Temporary Service."

It was apparently the original intention of the Admiralty to produce the same homogeneity amongst engineer officers trained at Keyham as exists in the case of executive officers trained on the *Britannia*; but, as the real importance of the engineer personnel has never been appreciated by the executive officers at the Admiralty, Keyham College has been allowed to drift into such a very unsatisfactory condition that, whilst in 1898 there were six applicants for every vacancy, in 1901 there were only two. It is true that in the present year there has been a slight increase, but the value of the apparent improvement is indicated by the fact that four School Board boys entered at Portsmouth and passed the examination. One failed medically, and the remaining three refused to accept appointments; it subsequently transpiring that they had competed merely for educational practice, and with no intention whatever of entering the Navy. This year thirty-three candidates were accepted for Keyham, but no less than 73 per cent. were drawn from the agricultural counties of Devon, Hants, Kent, Surrey, Dorset, Lincoln, Herts, and Somerset. There was not one candidate from the great marine engineering centres on the Clyde or the North-East Coast, whence the best supply should naturally flow.

This anomaly is, no doubt, accounted for by the deterring influence of the more intimate knowledge pervading marine engineering circles regarding the disadvantageous conditions of service in the engineer branch of H.M. Navy.

In order to meet the great scarcity of candidates for Keyham College, the Admiralty, some time ago, issued a circular to the head masters of schools, urging them to send up boys for the engineering examination, but at the Conference of Head Masters held at the Guildhall, London, under the presidency of Dr. Jas. Gow, of Westminster School, the Head Masters' Association decided that they could not advise parents to embark their sons on so unsatisfactory a career as that offered by the engineer branch of the Navy, under existing conditions.

The supply from Keyham being inadequate, the Admiralty next introduced a system by which young engineers, who have received theoretical training in any of the technical colleges of this country, and practical training in any large engineering works, can compete by examination for "direct entry" into H.M. Navy as engineer officers. This system has also failed, as, at the examination held last month throughout the United Kingdom, only six candidates presented themselves, three of whom passed with a low percentage of marks, and it is a regrettable fact that not one application was received from the Durham College of Science at Newcastle, notwithstanding its chair of engineering, excellent engineering laboratory, and unsurpassed facilities for marine engineering education and training. The system of "direct entry" having thus hopelessly failed, the Admiralty decided to lower the standard of educational and practical requirements, and admit officers for so-called "temporary service." Although there was liberal advertisement, the result has been a complete fiasco, as no candidates presented themselves at the January examination, and only two in March, one of whom was accepted.

The Admiralty, however, are never at a loss for ineffectual and risky expedients when dealing with the engineer personnel, and the next step was to issue an order transferring engineering duties, in connection with hydraulic, pneumatic, and electric appliances on H.M. ships, from engineer officers to executive officers, and requesting the captains of the *Vernon* and *Excellent*, together with the chief inspector of machinery at Portsmouth Dockyard, to consider and report upon the methods best calculated to facilitate the adoption of the change, including the necessary courses of instruction. The captains drew up a scheme of technical and practical training, embracing, amongst others, the following items :—

Specifications for materials. Working drawings. Approximate estimate of the time and cost of each operation for the finished article. Different metals for different parts. File work. Filing round and square holes. Chisels. Using hammer and chisel. Tools. Tempers. Forging. Lathes. Cutting internal and external threads by hand and with machine. Drilling. Tapping. Soldering. Brazing. Burning pieces on a casting. Making rivets. Bushing holes. Putting on patches. Making steel and bronze nuts, electrical terminals and contact pieces. Following from start to finish every operation in connection with Whitehead torpedo. Testing fractures, patterns, material used, where procured, and price.

HOW TO BECOME AN ENGINEER IN 168 HOURS.

Any engineer knows that this course would, in accordance with the ordinary accepted methods, involve from five to six years of very hard work. Yet the captains of the *Vernon* and *Excellent* fixed the duration of the training at one month ! Allowing twenty-eight working days at six hours a day, the total training would occupy but 168 hours. How to become an engineer in 168 hours ? The proposition is so absolutely farcical, that one would dismiss it with a smile were it not for the knowledge that the gravest issues are involved in these nonsensical proposals, and that their translation into practice would sap the actual realisable fighting efficiency of every ship in the fleet.

The only value of the report apparently lies in the fact that it affords convincing evidence that the executive officers who submitted it cannot lay claim to the possession of even elementary engineering knowledge and experience, and it is this non-appreciation of engineering prevailing amongst executive officers of even the highest ranks which renders the question of there being no engineer officer on the Board of Admiralty one of national importance.

The chief inspector of machinery at Portsmouth Dockyard refused to endorse this scheme.

The present position is that, even on the attenuated and inadequate Admiralty basis, there is a shortage of fifty-one engineer officers, and this shortage will undoubtedly increase until the Admiralty decide to place engineer officers in H.M. Navy on the same basis as executive officers in respect of rank, pay, promotions, pensions, honours, etc.

THE PRESENT UNSATISFACTORY CONDITION.

It is obvious that engineers of education and experience will continue to refuse to enter the Navy as civilian officers with no military status. It should also be recognised by those who control the destinies of the Navy that engineering is a profession, and that, in view of the immense issues involved in the maintenance of the mechanical efficiency of our floating fighting machines, engineer officers in H.M. Navy should be gentlemen of the highest technical and practical attainments. Admirals of the old school, with no knowledge whatever of professional engineering, who in public venture to compare engineer officers to "Lascars with oil cans," refer to them in the press as "a scratch collection of the residuum of the engineering profession," and avail themselves of every other opportunity for depreciating and snubbing them, have contributed not a little to the present deplorable state of affairs, and it needs the strong hand of resolute statesmanship to overcome the intense traditional prejudice against engineer officers which is still promoted by many executive officers at every available opportunity.

There is no engineer officer on the Board of Admiralty; engineer officers cannot sit on Courts Martial; their signatures to their own reports are suppressed, and although there are officers from the executive, paymaster, and marine branches attached to the Naval Intelligence Department, there is no engineer officer. A well-known captain (R.N.), in writing to the press some time ago, exactly expressed the feeling entertained towards the engineer branch by executive officers, when he referred to it as the "alien profession" "*in* the service but not *of* it," and this studiously cultivated feeling of disdain is intensified by the action of the Admiralty in persistently lowering the standard in their anxiety to obtain engineer officers without increasing the attractions of the engineer branch.

LOWERING THE STANDARD OF ENTRY A DANGEROUS EXPEDIENT.

Unfortunately, the practice of lowering the standard of entry has already been so extensively adopted from time to time that its accumulative effect has at last appreciably diminished the homogeneity and average efficiency of the entire engineer personnel afloat.

Warships which were formerly in charge of officers of chief engineer rank are now in charge of junior officers, whose increased responsibilities are not compensated for by accelerated promotion, and many ships having engines up to 4,500 i.h.p., with Belleville and other water-tube boilers — which admittedly require highly skilled and experienced attention —carry no commissioned engineer officer, but are in charge of an artificer engineer.

The whole tendency of modern education is to raise standards in all professions, and with the immense and rapid developments in mechanical science as applied to naval warfare, the lowering of the standard of engineer officers is a highly dangerous expedient.

In view of the existing similarity between the earlier education and training of executive officers on the *Britannia* at Dartmouth, and engineer officers at Keyham College, Devonport, and the tendency towards a yet closer similarity created by the growing importance of scientific education for executive officers, a scheme for their common entry to the *Britannia* for joint early training in naval discipline, mathematics, chemistry, physics, etc., would commend itself as being likely to result in efficiency and popularity.

Those destined to become engineer officers would be subsequently transferred to Keyham for a thorough course of practical training in the dockyard, and a further training in applied science by lectures in the college.

Reforms, sufficiently radical and comprehensive to be successful, are to be looked for only in the direction of either the scheme proposed by the North-East Coast Institution of Engineers and Shipbuilders, or the new personnel system of amalgamation of the executive and engineer branches adopted in the United States Navy, *plus the compulsory performance by each officer, under definite regulations, of engine-room duties during an adequate proportion of his whole term of service.*

The pivot point, however, of this and kindred questions is human nature, and the partial failure of the new personnel system in the United States Navy is, in a great measure, attributable to the fact that officers have not been compelled by regulation to undertake a definite share of engine-room duties. The majority have, therefore, very naturally chosen to perform deck duties in preference to the relatively harder and less agreeable work in the engine-room, thus completely perverting the whole spirit and intention of Admiral Melville's scheme, which, had it either left less to the spirit and volition of officers, or been complied with by the latter in good faith, would, undoubtedly, have resulted in greater success.

PAGE'S MAGAZINE

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OUR MONTHLY RÉSUMÉ.

LONDON, 20th August, 1902.

The "Dead Season."

It is a curious fact that orders for ships are usually few and far between in the height of summer. Whatever be the reason, the period between May or June and August is what may be called the "dead season" in the shipbuilding world. But by about the middle of August if there is going to be any revival in demand it should be then apparent, for contracting is usually most active between August and November. The output also for July is generally a small one because of holidays. In Scotland, for instance, our largest shipbuilding centre, the Glasgow Fair holidays take a good half out of the working month, because even after the men resume they are "soft" and lazy for another week or so. There is, therefore, not much for us to record here of the month just left behind us as these lines go to press. There has also been a lull in the stream of sensational stories about possible or impossible Combines. The latest achievement seems to be that of Sir Christopher Furness, who, with Morganatic appetite, is credited with having absorbed the Gulf Line (of Greenock) with a capital of £250,000. With the very meagre details that are at present available it would be premature to speak too positively about the new Canadian subsidised line of steamers which is to run direct from Canada to South Africa. The statement at present made is that the Canadian Government has arranged to pay a subsidy of £30,000, and the British Government a subsidy of £15,000 a year, to a combination of the Allan, Wilson-Furness, and Elder-Dempster lines, which undertake to run a monthly service of freight and passenger boats between Canada and South Africa.

Quarterly Shipbuilding Return.

According to the quarterly statistics of Lloyd's Register it appears that, excluding warships, there were 406 vessels of 1,129,582 tons gross under construction in the

United Kingdom at the close of the quarter ended June 30th, 1902. The particulars are as follows, with figures for the corresponding period in 1901 :—

Description	June 30th, 1902. No.	June 30th, 1902. Gross Tonnage	June 30th, 1901. No.	June 30th, 1901. Gross Tonnage
Steam.				
Steel	[illegible]	[illegible]	[illegible]	[illegible]
Iron	[illegible]	[illegible]	2	[illegible]
Wood and Composite	1	160	2	72
Total	[illegible]	[illegible]	[illegible]	[illegible]
Sail				
Steel	[illegible]	[illegible]	[illegible]	[illegible]
Iron		—	—	
Wood and Composite	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]
Total Steam and Sail	[illegible]	[illegible]	[illegible]	[illegible]

The present returns show a reduction in the tonnage under construction of about 111,000 tons as compared with the figures for the preceding quarter, and of about 284,000 tons as compared with the high total of September, 1901.

Lloyd's figures only include vessels over 100 tons each, and the following table gives the number and tonnage of merchant vessels (excluding warships) now under construction in some of the principal shipbuilding districts of the country as compared with those for the same period last year. Each district includes all places in the neighbourhood of the port after which it is named :—

District		June 30th, 1902. No.	June 30th, 1902. Gross Tonnage	June 30th, 1901. No.	June 30th, 1901. Gross Tonnage
Belfast	Steam	21	[illegible]	21	[illegible]
	Sail	—			
	Total	21	[illegible]	21	[illegible]
Barrow, Maryport and Workington	Steam	[illegible]	[illegible]	4	[illegible]
	Sail		15	[illegible]	45
	Total	—	[illegible]	[illegible]	[illegible]
Glasgow*	Steam	[illegible]	[illegible]	[illegible]	[illegible]
	Sail	[illegible]	[illegible]	[illegible]	[illegible]
	Total	87	244,334	85	244,665
[illegible]	Steam	[illegible]	[illegible]	[illegible]	[illegible]
	Sail	2	[illegible]	2	[illegible]
	Total	[illegible]	[illegible]	[illegible]	[illegible]
Hartlepool and Whitby	Steam	[illegible]	[illegible]	24	[illegible]
	Sail	—			
	Total	[illegible]	[illegible]	[illegible]	[illegible]
Middlesbrough and Stockton	Steam	[illegible]	[illegible]	[illegible]	[illegible]
	Sail	—		—	
	Total	[illegible]	[illegible]	[illegible]	[illegible]

District		June 30th, 1902. No.	June 30th, 1902. Gross Tonnage	June 30th, 1901. No.	June 30th, 1901. Gross Tonnage
[illegible]	Steam	[illegible]	[illegible]	[illegible]	[illegible]
	Sail		—	—	
	Total	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Steam	[illegible]	[illegible]	[illegible]	[illegible]
	Sail				
	Total	[illegible]	[illegible]	[illegible]	[illegible]

* Glasgow and Greenock figures include those for the Forth, Tay, [illegible]

New Warships. The following is a statement of the war vessels which are at present under construction. It has been assumed that a vessel may be regarded as "under construction" from the commencement of the laying of her keel to the time when she is ready for her steam trials. Of course, when this latter stage is reached, the guns have usually still to be placed on board, and the vessel to be fitted out before she is ready to be commissioned, but she is, nevertheless, structurally complete :—

Nationality.	Description.	Number.	Displacement. Tons.
British	1st class battleships	8	121,050
	1st class armoured cruisers	15	153,200
	2nd class protected cruisers	2	11,700
	3rd class protected cruisers	1	3,000
	Sloops	4	[illegible]
	Torpedo boat destroyers	12	[illegible]
	Torpedo-boats	5	950
	Submarine boats	5	not stated.
	Total	52	298,790
[illegible]	Armoured vessels	2	23,600
	Protected cruisers	1	4,000
	Torpedo boat destroyers	2	750
	Total	5	28,350
	British and Foreign total	57	327,140

Year's Shipbuilding in the United States. During the fiscal year, which ended on June 30th, 1,657 vessels of 473,981 gross tons were built in the United States and officially numbered, compared with 1,709 vessels of 489,616 tons in the previous fiscal year. The decrease is in sailing vessels and canal boats, barges, etc. This year's new sail tonnage is 101,072 tons; last year's was 128,099 tons. This year's new canal boats, barges, etc., aggregate 57,502 tons; last year's reached 88,331 tons. New steel steamers aggregate 275,479 tons, compared with 235,265 tons last year. Included in the total new tonnage are 94 vessels each of over 1,000 tons, aggregating 315,062 tons, or two-thirds of the output. Of this construction 41 steel steamers of 158,631 tons were built on the Great Lakes. The Lakes have built for ocean trade two West India fruit steamers of 1,820 tons each, one cargo steamer of 2,182 tons, and two large cargo steamers of 5,270 tons each cut in two to pass the Canadian canals. The output of completed steel steamers on the seaboard has been much below the indications of last July. The launching of nearly every large steamer has been delayed from three to eight months, and some which by this time were to have been in operation are still on the ways. The delays have been partly due to the steel strike last summer, to the great demand for structural steel in all directions, to low ocean freights, and to the lack of new shipbuilding orders, which has left builders and owners without motive for haste. Last July 255,000 tons of ocean steel steamers were under construction or under contract, while at present only about 160,000 tons are under construction, and no new large seaboard contracts are reported.

The Boiler Question.

The Navy Boiler Committee which was appointed on September 6th, 1900, evidently consider that their work might very well be continued, as they seem unable to fix definitely upon a type of boiler which will serve all purposes, and yet be durable. There is, however, about their last report more of definiteness than characterised the preceding one. The advantages of water tube boilers for naval purposes are so great, chiefly from a military point of view, that providing a satisfactory type can be adopted, it would be more suitable for use in the Navy than the cylindrical type; but the Committee are pronounced in their opinion that the Belleville boiler has no such advantage over other types as to lead them to recognise that as the best type to be adopted in the Navy.

The Belleville Boiler.

At the same time, they fully recognise that the Belleville boiler, when new and in sound condition, is a good steam generator, but its rapid loss of efficiency in ordinary work in commissioned ships, the serious character of the defects which have been developed in it, and the great care required in its manipulation render it, in the opinion of the Committee, undesirable to fit any more of this type in H.M. Navy. To obtain satisfactory results in working these boilers in the face of the disadvantages named, more than ordinary experience and skill are required on the part of the working staff. The Committee find that serious defects in the boiler casing have made their appearance in several instances, and have rendered the vessels in which they occurred unserviceable for long periods. Elaborate details of repairs indicate a very wide variation in the extent of defects, not only in the boilers but in the casings, and this notable feature has led to the conclusion that many of these defects are not inherent to the system but rather to the manufacture or to the supervision given on board.

Belleville Defects.

The Committee, in dwelling upon the defects, name several which are, however, inherent to the Belleville boiler system. These include the corrosive decay of the baffles in the steam collectors, and of generator and economiser tubes. This has now been greatly reduced by the use of lime and zinc, but great care has to be taken to prevent choking of the water gauge connections in consequence of the free use of the lime. The next is the rapid wear of the working parts of the automatic feed apparatus and the non-return valves in the down-take pipes. The third is the melting of fusible plugs owing to uncertain circulation; the fourth, the deposit in the tubes about the water-line, but specially in the wing elements, due to impure feed-water and involving failure of the tube; and the fifth, and last, is the excessive expenditure of coal and of fresh water for boiler-feed make-up, as compared with vessels fitted with cylindrical boilers.

Requirements.

The Committee point out that, as compared with the cylindrical boiler, satisfactory water-tube boilers should possess the following advantages: Less delay in steam raising; less liability to damage if the boiler be struck by a projectile; greater ease of repair and renewal of parts; less weight for the power generated, considering the weight of the boiler installation only; ability to carry a higher steam pressure;

and larger fire-grate area for the same floor area, with consequent less forcing for full power. These advantages are possessed to a considerable extent by the Belleville boiler, and on the competitive trials of the *Hyacinth* and *Minerva*, the Belleville boilers proved more efficient as regards evaporation than the cylindrical boilers as originally fitted, but after the retarders were fitted in the latter the efficiencies were nearly equal. The long runs to Gibraltar and back also proved that in several respects, notably in the loss of feed water and in economy of coal consumption, as well as in immunity from accident during ordinary working, the cylindrical boilers were considerably superior to the Belleville.

Large Tube Boilers.

The Committee are still of the opinion that the Babcock and Wilcox, Niclausse, Dürr, and Yarrow large tube boiler, all of which are of the straight tube type, merit, as proposed in their first report, extensive trial in the Navy. These types have few of the disadvantages of the Belleville boiler with most of its advantages. They all have "drowned" tubes, and the water level, as shown by the gauges, is practically the level of the water in the boiler; they do not require a much higher pressure to be maintained in the feed pumps than in the boilers, nor in the boilers than at the engines; the use of automatic feed regulators of an extremely delicate type is not necessary; the circulation is fairly well defined, and is much freer than in the Belleville. From such experience and evidence as the Committee have had before them the loss of water will be much less than with the Belleville; and, finally, these boilers appear to be much more likely than the Belleville to be free from accident under ordinary conditions of service. The Babcock and Wilcox boilers in the Wilson Liner *Martello* made 91,000 miles running in fourteen months, with less than a week in port at the end of each Atlantic run, and the only repairs required had been those of the ordinary upkeep of any boiler, while only six tubes required renewal. Similarly satisfactory results are noted in connection with other merchant ships, and the same type of boilers in H.M.S. *Sheldrake* were found in good condition and had given little trouble. As regards the Niclausse boiler, the only expression of opinion is that those in H.M.S. *Seagull* are several years old, and have proved generally satisfactory. As to the Yarrow boiler, it is anticipated that the use of tubes of 1¾ in. in diameter will be more efficient and will give better results than the small tubes. Two methods of heating the air have been fitted in connection with Yarrow boilers in the Dutch and Austrian navies, one by means of tubes in the up-take, and the other by fitting an outer casing completely over the boiler and the up-take, and passing the air-supply through the space so formed.

Recommendations.

From the evidence it appears that no type of water-tube boiler at present in use is on general service so economical as the cylindrical boiler, and that a large percentage of the coal used is expended for auxiliary purposes in harbour. Until a thoroughly satisfactory type of water-tube boiler is obtained, the Committee recommend that in large cruisers and battleships cylindrical boilers of sufficient power to work the auxiliary machinery, and to drive the ship at her ordinary cruising speed, should be fitted, the steam pressure being the same for the water-tube and cylindrical boilers—210 lbs. per square inch—so as to give 200 lbs. at the engines. By this means considerable saving in coal will be effected. The water-tube boilers could, when not in use, be kept clean and perfectly efficient for driving the ship at high speeds when economy of coal relatively is not so important. The cylindrical boilers should be fitted with retarders in the tubes, and with special means for circulating the water while raising steam. The Committee recommend that retarders should be fitted in the tubes of all cylindrical boilers, believing that they will render existing boilers more efficient and more economical than at present. The former recommendation of the Committee to fit a combination of cylindrical and water-tube boilers has been carried out in the case not only of one of the battleships of the *King Edward* class, but also in the cruisers of the *Devonshire* class, the four types of water-tube boilers recommended—Babcock and

Wilcox, Niclausse, Dürr, and Yarrow—being utilised.

Small Tube Boilers.

Altogether, the Committee considered thirty-six boilers, out of which they made their selection of four, leaving the others for future consideration. As to the small tube boilers, they pronounced the opinion that they are unsuitable for vessels above the size of third-class cruisers ; but Mr. List, one of the members of the Committee, thinks the Thorneycroft-Shultz is adapted for use in combination with cylindrical boilers, provided the tubes are not less than $1\frac{3}{4}$ in. external diameter, and of a given thickness ; that the curvature of the tubes is such that a flexible cutter can be passed through them for the removal of scale ; that the arrangement of the tubes is such that there will only be a small percentage of discharge from the tubes above the water line ; and that there are no air locks in them when the boiler is filled right up.

The Awakening of the Railways.

One of the most important railway announcements of the month was that made by the Chairman of the North-Eastern Railway at their recent half-yearly meeting. In consequence of the increasing competition of electric tramways the Board has decided as an experiment to equip 37 miles of standard gauge line with electric traction. The section between Newcastle, Tynemouth, and Whitley Bay will probably be the first to receive attention. There are rumours that several of the other leading railways are contemplating similar decisions, and it seems probable that electric traction will soon be in vogue on some of the suburban lines of the London and South-Western Railway. Another gratifying sign is that greater attention is now being paid to automatic signalling devices. The South-Western Company has quite recently installed on its main line between Andover and Grateley a series of automatic signals, controlling five consecutive block sections, and in addition to this enterprise we learn that the North-Eastern Company are contemplating installing on their main line near York the "Hall" electro-automatic track signals which are in extensive operation in the United States.

The Coming Americanisation of the Goods and Mineral Departments.

The Americanisation of the passenger department, which is now in evidence on most of the British lines, will, in all probability, be followed by a similar development in the mineral and goods departments. Several of the companies are adopting —if somewhat cautiously—the large steel waggons of from 30 to 50 tons capacity, which have been the subject of experiment for some time, and they at last appear to have realised the importance of reducing the dead load proportion of their present rolling stock. As an illustration of the considerable numbers of these cars employed by our competitors, it is instructive to note that whereas there are not probable more than 80 to 100 in the whole of Great Britain, the Pennsylvania Railroad a week or two ago placed an order with a single firm in Pittsburg for 12,000 pressed steel cars of various types, *each of 50 tons capacity.*

Locomotive Piston Valves.

In the interesting paper read on July 30th before the Institute of Mechanical Engineers by Mr. Walter M. Smith, M.Inst.C.E., of the North-Eastern Locomotive Department, the author describes the form of piston valve which he invented and introduced in 1887, prior to which period piston valves had been experimentally tried, only to be discarded. It may be gathered from his paper that he kept mainly in view the following objects : (1) More efficient distribution of steam ; (2) reduction in coal consumption ; (3) diminution in the amount of power absorbed by friction in the valves and valve motion ; (4) utilisation in actual efficient work of the power thus saved ; (5) reduction in cost of repairs and in time occupied in repairs, owing to the simplicity of the general arrangement of cylinders and valve motion ; (6) lessened cost of construction ; (7) free release of water trapped in cylinders and consequent diminution of priming. These are, of course, points of much importance. It is most desirable to reduce coal consumption and repairs-cost where possible, but not at the cost of diminished efficiency. Mr. Smith claims that his valves, while saving expense in coal and repairs, are not subject to this drawback. With regard to lowered coal consumption, his figures certainly show valuable results, a saving of 9·1 per cent. and 13·3 per cent. respectively being recorded as shown by the first goods engine and express engine fitted with his valves. Moreover, Mr. Smith states that the wear is so very small as to be almost inappreciable; thus his valves lessen the cost of upkeep by rendering less frequent the need of renewal. It is mentioned that North-Eastern engine No. 2,011, the first of a new four-coupled type which came out in 1899 and was fitted with these valves, had run 139,543 miles up to the end of the year 1901, without any appreciable wear in the valves or valve-gear being discernible. Theoretically, without doubt, the advantages of piston-valves are great, and in the instances cited by Mr. Smith they appear to have been realised in actual practice. But a further and more extended use of the method would seem to be desirable before any definitive opinion can be expressed as to the superiority over other valve systems which is claimed for them. It may be admitted, however, that hitherto the weight of evidence based upon experience—so far as precise results have been formulated—apparently goes in their favour.

The Labour Difficulty in South Africa.

There are abundant anticipations of a "boom" on the Rand, but no trustworthy signs of it. On the contrary, the lack of one of the essential elements presents an almost unsolvable problem. In June, 1899, the mines of the Witwatersrand were employing 97,800 natives, and it was estimated that another 15,000 were required to bring the force to its full complement. In addition to those natives actually employed at the mines, there are great numbers employed at Johannesburg and on the Rand as house-boys, drivers, cooks, and in other domestic work. The number of these may be estimated at about 30,000, and there will be quite another 30,000 employed on mines in mining towns outside of the Rand; so that the mining industry of the Transvaal may be calculated to give employment to a grand total of over 150,000 natives. The demand is now estimated at upwards of 200,000.

The Number of Natives at present Available.

What is the situation to-day? The returns of the Native Labour Supply Association show that up to June 30th 42,800 natives had been recruited by it, and 42,060 distributed to the mines. This is so much below the actual requirements that a great many gloomy predictions are being made, and the impatience of the mining public is undoubtedly increasing. The staff of the Association are, however, not discouraged, but are sanguine that from the present month the supply should commence to reach a monthly total of 7,000, enlarging gradually to 10,000 by December next. Accepting even these figures, it is apparent that some considerable time must elapse before the quantity of men available reaches the 200,000 the mine owners think they will require. The white skilled miners are also regarding with great suspicion the offer of some of the mining companies, to unemployed whites, of five shillings a day, with shelter and rations, for a ten hours day—six on Saturdays. This they think is the thin end of the wedge for a reduction of miners' wages all round.

Sinking Pumps.

A point much neglected, but of considerable importance in mining operations, has been recently considered at a meeting of engineers at Leicester; that is, the employment of a proper pump in sinking operations. At this meeting well-sinking was under consideration, but the question becomes far more urgent when the more serious operation of shaft-sinking is in contemplation. The usual plan is to buy the cheapest pump, whether it be suitable or not, and as a rule the result is deplorable owing to the various parts of the apparatus giving way in course of work. But it was shown that, provided due care is observed, pumping operations can be carried on with ease and expedition without any of the troubles incident to the practice just mentioned. The most suitable pumps should be employed, and with them what is equally important, suitable tackle and winches. This point has been very much neglected in the past, because the tackle and winches cost roughly double as much as the pump. But, properly provided with these appliances, it is certain that progress will be twice as great as by the old-fashioned system. Some of the better makes of suspended steam pumps are regarded as the most suitable, hung by long link chains, so that a shackle can be put on the chain at any link, and lifting appliances tackled on at any point in a few moments. The lifting tackle should consist of steel wire ropes and blocks with a winch, single or double-barrelled as circumstances may dictate.

Shaft Sinking by Percussive Boring.

Some excellent sinking has recently been achieved by means of Herr Pattberg's sinking appliances. These consist of a cutting-head mounted on a strong wooden or wrought iron frame-work, supported by a tubular boring rod, two mammoth pumps, the whole slung from a scaffolding over the shaft, and an oscillating drum and engine for giving the reciprocating motion to the cutter system. The accessories are water pumps and air compressors.

The work that has recently been done consists of three sinkings in two shafts 21 ft. in diameter through loose ground consisting of sandy clay, clay, quicksand, sandy marl, and accreted marl. The first sinking was 145 ft. in forty-four days, the second a little over 95 ft. in eleven days, and the third 188 ft. in fifty-nine days. The greatest speed obtained was 16½ ft. each in two successive days. The whole piece of work compares remarkably well with any other method of sinking.

The operation consists of lifting the cutting head and letting it drop 7 or 8 inches, fifty or sixty times a minute, giving a turn each time. The borer consists of a series of cutting edges or chisels, or of a continuous cutting edge, set obliquely in the frame so as to cut a surface inclining towards the centre; the operation takes place with water in the shaft, and, moreover, water under pressure is forced down the hollow boring rod and escapes by special channels at each chisel. The detritus and muddy water run to the centre and thence are lifted to the surface by the mammoth pumps, which comprise an inner and an outer pipe, and down the annular space between the two compressed air is forced, and at the lower end escapes into the inner tube and carries with it the detrital sludge.

Sinking drums are employed at the start, and continuous tubing is made to follow the progress of the cutting head by means of hydraulic presses. Germany was the scene of this successful piece of work, and at the pit "Rheinpreussen IV." the total cost of a completely new installation and plant was £10,165, including everything, from pit frame and foundations to the air compressors, hydraulic presses, pump, and engines. The cutting-tool, mounted in a wooden frame and with a cutting edge of 21 ft., is 27 ft. high at the centre, and weighs 19,900 lbs.

A Recent Winding Engine.

"Made in Germany" applies to the most recent addition to France's winding engines for use in one of her coal mining enterprises. A German-made winding engine, constructed for the Société des Houillères de Ronchamp at Ronchamp, in the department of Haute Saone, has many special features. Spiral drums as well as taper ropes are used, and the engine is a twin-tandem compound engine, with separate condenser. The drums are installed at right angles to the long axes of the cages, and they are placed on parallel axes one in front of the other, the one nearest the pit head winding on the nearest cage, the other winding the farther cage. The pulleys are set in the frame one above the other. The large diameters of the drums are set both on the same side.

All points of compensation and safety have been particularly considered, special attention having been given to the positions of the drums and engines, the depths of the grooves in the spirals, the general construction and slope of the conical part of the drum, the prevention of overwinding, the ready manipulation of the engines, and steam economy.

The chief dimensions are: diameter of high-pressure cylinders, 27·56 in., of low-pressure, 39·40 in., stroke, 70·8 in., width of drum, 12 ft. 6 in., diameters of drum—largest, 35 ft. 5 in., smallest, 13 ft. 7 in. The wire ropes have a total length of 3,890 ft., include five different diameters, ranging from 1·77 in. to 2·28 in. and each rope weighs 14,404 lbs., of which 3,394 ft., weighing 12,257 lbs., will be generally in use; the rest is made up of some spare laps on the drum, and a length available when required in the sump. The work to be done under ordinary conditions is to lift 5,026 lbs. of coal 3,280 ft., the total load with cage, rope, and waggons being 27,292 lbs.

The frame of the drum is of wrought iron, and it is covered with plates to which the rolled sections of the spiral are rivetted.

Ore Concentration by Oil.

A process attracting some attention in mining and metallurgical circles is that in which oil is being employed to separate certain metal-bearing minerals from the valueless rock with which they are found associated when brought out from a mine. It is well known that from time immemorial advantage has been taken of the difference in specific gravity to separate the small quantity of valuable and heavy mineral from the vastly preponderating mass of rocky and lighter mineral matter, and multitudinous have been the appliances and practices devised to utilise to the best advantage the superior massiveness of the valuable mineral. In a gold mill anything in the way of greasiness was regarded with particular horror, but by the efforts of the originators of the new process all this is changed. Greasiness, represented by oil, is welcomed in abundance, and the chief object in the operation is to reduce the superior heaviness of the valuable material to such a degree as to make it float on water, whilst the valueless rock is allowed to sink.

This is achieved by mixing the pulverised ore and water with heavy petroleum oil. For some unexplained reason this entraps the valuable mineral and bears it up to the surface of the water, whilst the useless rock is discarded and remains beneath the water.

The appliances for carrying out the operation are very simple. The mixing and principal separation are done in long horizontal cylinders provided with a conveyor worm and baffles. The ore-bearing mixture is admitted at one end of the cylinder and the oil is allowed to drop in. The cylinder is caused to revolve, and so, accompanied by much mixing up, the oil, water, and ore travel automatically along the cylinder, and at the end of the journey they pass into a separating chamber. The ore with its valuable burden is run off, whilst the water with its rock is disposed of in any convenient way. The oil and concentrates are treated in centrifugal machines, by which the liquid matter is separated from the solid, and the latter (the concentrates) are ready for any further treatment that may be desired.

Gravity Work.

It is remarkable, however, what can be done by making use of the difference in specific gravity. Of this there are indeed innumerable examples dating back to times when records were first made, but there are few more striking than a recent experience in California. Two years ago, during nine months' work, 655,657 miners' inches of water removed 1,251,399 cubic yards of material, consisting of pay-gravel, varying from a few inches to 8 ft., with a barren overburden of the usual miscellaneous character, and varying in thickness from 50 to 130 ft. There was only a little over five farthings' worth of valuable material per cubic yard of material washed; nevertheless, by the ordinary means of washing away the lighter stuff and leaving the heavier to accumulate automatically, the operation was conducted at a profit.

Improvements in Galician Ozokerite Mines.

It is noteworthy that, after years of desultory working, the Galician ozokerite deposits, some attempt at systematic working is now being adopted; and a very complete installation is being introduced by the Galician Credit Bank on the Boryslaw field. The shafts are being properly protected, surface water tubbed back, pumps introduced to deal with the water in the deposits, ventilating appliances and electric light introduced, and, where necessary, the shafts are being deepened and well-protected loading stations provided. The main result will be that much poor stuff that has hitherto been wasted will now be brought to surface, and it is supposed will more than repay the cost of the improvements, without considering other advantages that must accrue.

Coking Indifferent Coal.

It is the custom nowadays to bewail the exhaustion of our coal supplies, therefore any suggestion relating to the better utilisation of coal should be duly welcomed. In England we have long adhered to the old and wasteful beehive method of making coke. After some half a century of persuasion, however, a few manufacturers have been prevailed upon to introduce the chambered oven system, and this method is now distinctly gaining ground. It is interesting to note that coals which cannot be regarded as coking coals, and which under the old condition of things could never have been used for coke, are now being converted into serviceable coke in chambered ovens. This is effected by compressing the finely divided coal employed before charging into the oven. The apparatus used consists of a deep rectangular trough about the size of the oven chamber, which is made adjustable to suit the size of any chamber; in fact, the bottom is movable and can be slid along, whilst both the ends and sides can be released when required. This trough, with accessory paraphernalia and the charging ram, is brought in front of the chamber to be charged. The coal is fed into the trough, and by means of a travelling mechanical stamper is compressed all along to the desired condition. The ends are then removed, the sides released a little, the oven door opened, and the block of compressed coal, along with the movable bottom of the trough, is pushed by the ram into the chamber. The door of the chamber is then partially closed, the bottom of the trough withdrawn, the door of the oven completely closed and luted, and a larger and better yield of coke is the result.

LOCOMOTIVE ENGINEERING NOTES.

Large and Small Railways

A CORRESPONDENT expresses the hope that the larger railways will not receive sole attention in these notes, but that some of the smaller lines will have a "look in" now and then. Most undoubtedly they will, relatively to the importance or interest of the work done, alike in the design and construction of new engine types, the improvement of old forms, and the results in respect of actual performances. It must be borne in mind, however, that the larger railways, as a rule, provide not only a greater volume of material for comment, but also often topics of superior interest, *per se*.

Eight-coupled Goods Engines.

Reference was made in the July notes of this series to the increasing use of the eight-coupled locomotive types for goods and mineral traffic in Britain. It has been pointed out that eight-coupled engines were used in Britain even before Mr. Webb introduced the type on the London and North-Western Railway, and therefore long before the Great Northern, Lancashire and Yorkshire, North-Eastern, Caledonian, and Great Central followed suit! Certainly, that is so. But the point intended to be emphasised was not the novelty of eight-coupled locomotives, but the extension of their use in Britain. Even in the United Kingdom they are no novelty, while, of course, the type is as "old as the hills" on the European and American Continents and in the British Colonies. Many years ago—in Mr. Archibald Sturrock's time—two eight-coupled tank engines were in use on the Great Northern, Nos. 474 and 475. But there was a prejudice against coupling so many as eight wheels, just as there was against using four-coupled engines on express trains, and as there has been in Britain, until lately, against using six-coupled locomotives on express work. But elsewhere the great advantage of having eight points of rail-contact in slippery weather has long been recognised, and now that this has at last obtained appreciation also in Britain, it is safe to predict that the type will never disappear while steam locomotion remains the standard mode of carriage. And electric traction has still much to learn before it can supersede steam on long-service.

A Condemned Electric Locomotive.

Many readers will remember the introduction, with many a flourish of trumpets, on the Western Railway of France, of a new electric locomotive that was to "whip creation." It was known as the Heillmann Locomotive, and was a sort of hybrid, being a steam engine and an electric-motor combined. The steam engine did not propel the locomotive, but simply actuated a machine by which the steam power was converted into electric force which propelled the engine. It was a vast and most ponderous machine, weighing well over 100 tons, and it was reputed to be capable of speeds quite American in their marvellousness. Of their actual attainment, save on paper, no authentic records exist. It is to be feared now that none ever will exist, for this marvellous engine was condemned to be dismembered, and its steam and electric-motors, all separated from one another, are said to be doing useful service in various *stationary* capacities. But as a locomotive the Heillmann no longer has any individual or collective existence. It may therefore be safely inferred that it was not a success or the harbinger of a new epoch-making class.

Multiplication of the "Atlantic" type.

There is a distinct indication at present that the so-called "Atlantic" type of express passenger engine will share with the six-coupled bogie type the bulk of the express services of the future. The six-coupled "Atlantic" arrangement is undoubtedly an effective one. The four-coupled driving wheels are right under the middle of the engine-length; the front end is carried on a four-wheeled bogie which "holds down" the road for the driving wheels, and there is a pair of trailing wheels under the foot-plate which averts any "tail-wagging," and permits the use of as large a fire-box as can be stoked by any human stoker of normal dimensions. Since the pioneer of that class, the well-known "No. 990" was put on the Great Northern by Mr. Ivatt, ten more have been added with very satisfactory results. But so far the total number of the class remains at eleven on the Great Northern, whereas some fifty of the eight-wheeled "1321" class, which came out almost simultaneously, have been built at Doncaster. These latter are, doubtless, much cheaper to construct, and do excellent work, but one would imagine that the advantages possessed by the "Atlantics" would in the long run outweigh their extra cost. That, however, is a pure matter of experiment and experience which no amount of theorising can possibly determine.

Lancashire and Yorkshire "Atlantics."

But although the "Atlantics" have not been multiplied on the Great Northern, their numbers are steadily increasing on the second, and indeed only other, British railway that has tried them, viz., the Lancashire and Yorkshire. Up to the beginning of the current year forty of the "1400" class originally designed by Mr. Aspinall had been brought into service on the Lancashire and Yorkshire, and during the current year a fresh batch has been turned out by his successor at Horwich, Mr. Hoy. They appear to have proved highly successful in all respects, and certainly have done by far the best work ever seen on the Lancashire and Yorkshire. It is noticeable, moreover, that the duty demanded of them is of a class very different from that which had to be tackled by the earlier locomotives of Mr. Aspinall's build, and those of his predecessor, Mr. Barton-Wright. The Lancashire and Yorkshire, formerly one of the slowest of British railways, is now among the fastest. The mere fact that it runs no fewer than twenty-nine daily expresses between Manchester and Liverpool, each booked at an average start-to-stop speed of virtually 55 miles an hour, is sufficient to place it in the first British speed rank, the latest North-Eastern and London and North-Western developments notwithstanding. It is curious that this very useful, although perhaps expensive, type of locomotive should, like the four-cylinder compound, find such limited acceptance in Britain, although so largely in use and useful in most other countries.

American "Atlantics."

In the United States of America, and also in Canada, the possibilities and advantages of the "Atlantic" type have long been fully grasped and utilised. Most of the famous trains on the American Continent are worked by locomotives of this class. Could it claim no other merit than its ready and convenient admission of a vast boiler and firebox, this alone would constitute an enormous recommendation in these days, when the combination of great power with large speed-capacity is an absolute essential in the modern express locomotive. But its other advantages of arrangement are so obvious as to need no elaborate demonstration.

French "Atlantics."

On the Northern Railway of France the success of the "Atlantic" or "Exposition" type, specially designed by Monsieur du Bousquet to meet the rapidly-increasing speed and weight of the fine express trains run by that company, has been so marked and so remarkable as to consitute an epoch in French—and, indeed, in European—locomotive practice. It will be remembered that two pioneer engines of this order, Nos. 2.641 and 2.642, were originally delivered simultaneously in the "Exhibition Year" 1900, the one to be shown at Vincennes, the other to run "parade" trains outside on its regular metals. In these engines, although certain standard details, such as the de Glehn system of four-cylinder compounding, the Walschaert valve-gear, etc., are adhered to, the locomotive itself is of absolutely new design, and the result has proved that Monsieur du Bousquet has produced an engine which assuredly has no superior in the world for express duty, if, indeed, it has any rival on all points, which is at least doubtful. Certainly no European locomotive holds such records for associated speed and weight-pulling. Eighteen more have been added to the original two, making twenty in all, and the last of the batch, No. 2,660, was only delivered at the end of July in this year. These eighteen are virtually identical with the first two, save in having six-wheeled instead of eight-wheeled tenders, the first and second pair of wheels being widely separated in order to leave space for the water-pick-up scoop with which these newest locomotives are also fitted, it being intended to lay down water-troughs at no fewer than five different points by no distant date. Other French lines are using engines of the "Atlantic" type, the Chemin de Fer de l'Etat, or State Railway, for instance, which imported several of these from the Baldwin Works in Philadelphia, U.S.A. Some of a similar type, also American in build, are likewise in use on the P.L.M. line, and it is understood that some on the de Glehn compound principle have been ordered by the Paris-Orleans Railway. But now the Chemin de Fer du Midi, or Southern Railway of France, has followed suit, and has ordered for its Bordeaux-Cette service two "Atlantics," which are to be exact reproductions of Monsieur du Bousquet's Nord "Atlantics," and which, like them, are to be built at Belfort by the Société Alsacienne de Constructions Mécaniques.

Dutch "Atlantics."

The "Atlantic" type has also been adopted in Holland as the new standard express type of the State railways. The Dutch "Atlantics" are in a large measure mere amplifications of the eight-wheeled four-coupled locomotive, which was previously the standard, and one of which, built by Messrs. Neilson, Reid and Co., was shown at the Paris Exhibition of 1900. Practically, that design of engine has been taken and lengthened as to its boiler and firebox, and a pair of trailing carrying wheels added under the footplate. In this way a very fine and useful locomotive has been evolved, and there is little likelihood of any reversion to earlier types now that the newer design has been afforded an opportunity of proving its value.

Belgian and Scottish Engines.

When the Chemin de Fer de l'Etat Belge, or State Railway of Belgium, deliberately adopted the "Breadalbane" or improved "Dunalastair" locomotive type, designed by Mr. J. F. M'Intosh for the Caledonian Railway, as the standard passenger class for that system, it was originally understood that these engines were specially intended for use on the heavier grades which are found on the Etat Belge system as it approaches the German frontier at Herbesthal. Five were built by Messrs. Neilson, Reid and Co., of Glasgow, to Mr. M'Intosh's designs, and were duly sent to Belgium. They gave such satisfaction that they have since been largely multiplied in their adopted country, many being constructed by Belgian firms, and these now are employed on the International express between Brussels and the French frontier, as well as in the German direction, replacing the older type with Belpaire fire-boxes, two middle pairs of wheels coupled, and rectangular funnels. Engines of the "Caledonian" type now come right into France, as far as Aulnoye, 134½ miles from Paris. It is noteworthy that Mr. M'Intosh's "Caledonian" design of goods engines was also adopted by the Belgian State line, and the two shown at the Paris Exhibition were of this pattern—high compliment to their designer and to his country!

NOTABLE BRITISH PAPERS OF THE MONTH.

A Monthly Review of the leading papers read before the various Engineering and Technical Institutions of Great Britain.

MECHANICAL APPLIANCES IN MINES.

At the Newcastle meeting of the Institution of Mechanical Engineers, Mr. R. H. Wainford, M.Inst.Mech.E., contributed an important paper on the subject of Coal Cutting and Drilling by Machinery. The advantages of this method over hand-labour are clearly demonstrated.

ADVANTAGES OF CURVING OR HOLING BY MECHANICAL METHODS OVER HAND-LABOUR.

Generally the machines do this work under the coal, whereas the miner holes in the coal, and from a commercial point of view a distinct gain in favour of machine practice is established, there being a reduction in the amount of slack made. Something like 90 per cent. of the coal got by machines will pass over a ⅞ screen mesh, as against 60 per cent. by the hand method. For the purpose of ascertaining the difference in selling values an exhaustive trial was made at a Lancashire colliery with these results :—

	£	s.	d.
*Hand-labour : 3 tons coal at 11s. per ton .	1	13	0
1 ton slack at 7s. 3d. per ton.	0	7	3

Value per ton, average, 10s. 0¾d.

	£	s.	d.
By machine : 8 tons coal at 11s. per ton	4	8	0
1 ton slack at 7s. 3d per ton . .	0	7	3

Value per ton, average, 10s. 7d.

An increase of 6¼d. per ton in value.

The foregoing figures are the result of work performed some time ago by a Winstanley disc coal-cutter, similar results are maintained at the present time, and whereas a miner produces 3 tons of coal to one of slack, a machine will get 8 tons of coal to one of slack. This advantage is somewhat discounted by the fact of slack being nearly as valuable as coal for coking purposes ; a better quality of coke is, however, made from disintegrated coal than from slack, as it is free from dirt—an element not entirely overcome by washing. If the coal is house or steam coal, then the advantage is fully maintained.

Therefore if 6¼d. can be realised in this manner, the amount may reasonably be placed to the credit of mechanical appliances, and then more than half of the shilling suggested as the possible saving is established

A DIRECT COMPARISON.

For the purpose of making direct comparison as to the work of machines *v.* hand-labour, it is advisable to fix upon normal conditions, and to do this a three-foot seam may be reasonably and fairly regarded as the average. Coal can be holed by machines in this thickness to advantage; as they get thicker the saving is decreased, and as they become thinner they increase ; the machine may cease to show a gain when the thickness exceeds 5 ft., on the other hand the best results have been attained in seams under 2 ft. thick. A good miner will hole, curve, get, and fill three tons a day of eight hours in a three-foot seam under normal conditions, and in so doing will have earned, say, 7s. 6d. ; the cost for "holing or curving," getting and filling is therefore 2s. 6d. per ton. There is little doubt as to this figure, viz., 2s. 6d. per ton, being below the average on the total output of Great Britain, so the rate may be accepted.

CAPITAL OUTLAY.

The capital outlay for a complete coal-cutting plant is here considered, with allowances made for interest on capital, depreciation, repairs, cost of running, stores, etc., and a figure arrived at to stand against the machine.

The estimated cost of a single coal-cutting machine plant :—For one machine complete with all fixings and power plant, exclusive of boiler, engine house and foundations, £1,000 ; the standing charges are as follows :—

	£	s.	d.
For interest and depreciation at 15 per cent. per annum of 300 working shifts .	150	0	0
For repairs and [illegible]	75	0	0
For power (fuel)	60	0	0
	£285	0	0

£285 ÷ 300 [illegible] per shift.

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* [illegible] Kingdom."

The [illegible] complete, as estimated above, includes engine and dynamo, electric standard type coal-cutter and all accessories and connections from the generator to the machine at a face half a mile from the shaft, erecting the plant and running it for ten days. No account is taken for attendance at the generating station. It may be here suggested that when the cutters are worked on the night turn, which is usual, the fuel account would hardly be appreciable, as the steam in this case will be drawn from boilers that are not in use although in steam.

This is for an electric installation ; the compressed air plant may be taken over all to be about equal in cost. Some slight differences occur in the prices for the Hurd, Clarke-Stephenson, and Diamond ; the sum £1,000 is not exceeded, however, in any case.

The coal-cutter will hole or curve to a depth varying from 3½ ft. to 6 ft. ; the average working depth is 4½ ft., and in eight hours will travel across a face seventy yards under normal conditions, holing or curving through a distance on the face, which when got and filled equals 100 tons ; the same falling-off and increase in the make applies here, so the average may be taken as stated. Sometimes two men only are required to look after the machine, and never more than three ; if these men are paid at the same rate as the miner, the holing through seventy yards will then cost 7s. 6d. × 3 = 22s. 6d., less if anything, because two men may be enough to do the work.

For getting down and filling (11d. per ton standard + 57½ per cent.), cost per ton = 1s. 6·46d., and the total for [illegible] getting and filling 100 tons is

	[illegible] per [illegible]	per [illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
„ holing, getting, and filling ..	[illegible]	[illegible]

Bringing forward the amount estimated as the standing charge per shift against a single machine plant, we have the following results :—

	£ s. d. per ton.	s. d. per ton.
For holing, getting, and filling 100 tons	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]

The reduction, therefore, is 6·56 pence on the 2s. 6d. rate in favour of the machine, and, together with the amount previously estimated as savings due to increased selling value, etc., of 7·25 pence = 13·81 pence. The unfavourable points in the foregoing estimates are found in the fact that, whereas a single-machine plant is put down at £1,000, a two-machine plant costs £1,575, a three-machine plant £2,125, and a four-machine plant £2,950 [illegible]

ADVANTAGES OF COAL-CUTTING MACHINERY.

When coal-cutting by machinery is efficiently carried out, the working face is kept straight and clean. Undercutting to greater depths than possible by hand renders timbering required less frequent and therefore less costly, and also a reduction in the number of shots to be fired is found from experience to be considerable. By keeping a straight line the coal breaks away more easily, especially when aided by increased depth of hole. At a mine in Yorkshire forty shots were fired per day when the holing was made by hand ; the machine method reduced the number of shots necessary to seven. Another good feature in the new method to be noted is that work can be carried on regularly ; to keep a face moving forward at a set speed, varying conditions are minimised, and so the work becomes easier to cope with and less hazardous.

POSSIBLE PRACTICAL OBJECTIONS TO MACHINE PRACTICE.

From the practical point of view some objections to machine practice occur ; they present themselves differently in each mining district; discussion may indicate them variously. One of the chief objections to the system is the difficulty in finding men to attend the machines, possessing sufficient mechanical skill and pit experience to enable them to cope with contingencies at the face as they are met ; but this hardly reflects discredit upon the mechanical methods directly. Miners can readily apply themselves if dealt with with tact and encouraged in the work. At some places machine methods have recorded a failure, traceable very often to the plant being either badly designed or lacking the necessary power, but most often to the system being taken up in a desultory manner, for it seldom happens that a new idea does not meet serious difficulties, due to prejudice, either on the part of the management or the men, or both.

COST IN YORKSHIRE.

The author concludes with some very interesting figures, which we give below :—

Total underground cost of working a seam 3 ft. 3 in. at a depth of over 500 yards in a Yorkshire Colliery by means of the "Diamond" deep undercutting machine, holing to a depth of 5½ ft. in stiff fireclay.

	Cost per ton. s.	d.
Coal getting (11d. per ton standard price, including 57½ district percentage) ..	1	6·46
Coal-cutter men, paid by day		4·82
Cleaning up, ripping (9 ft. roads), horse-keepers, hurrying and hanging on, main roads, bye work, and superintending, including deputies, shot-firers, etc.	[illegible]	[illegible]
	[illegible]	[illegible]

Approximate output from seam, 4,500 tons per week.

Average tonnage for fillers, 6½ tons per shift.

LIQUID FUEL FOR STEAMSHIPS.

MR. EDWIN L. ORDE, of Newcastle, in the course of a paper read at the recent meeting of the Institution of Mechanical Engineers, attributed the slow advance made in the use of liquid fuel for steamships to the fact that until comparatively lately it has not been obtainable in such quantities as are required to make it commercially useful.

For many years the Caspian Sea was the only place where liquid fuel was used in the furnaces of marine boilers, and as the quantity available was not sufficient to allow of its export, it could only obtain a very limited application. Of late years, however, the sources of supply have largely increased in number, and now that the large oil-fields of Borneo and Texas are in active operation, and commercial enterprise only needs the stimulus of demand to organise distributing stations, the question of the adoption of liquid fuel on a large scale appears to need for its solution only the close attention of engineers. The principal sources of supply are the fields of Borneo, Burmah, the Caucasus, Texas, and California ; but there appear to be indications that further supplies exist, and were the demand assured, would be explored and developed.

ITS COMBUSTION IN BOILER FURNACES.

The conditions that attend and the reactions that take place in burning liquid fuel in boiler furnaces present a problem which has apparently not received the attention which it deserves. Petroleum vapour depends entirely on temperature, and it is therefore almost impossible to collect samples when actually burning it in a furnace. It seems obvious that the first effect of the furnace heat on the petroleum spray is to liberate hydrocarbon vapours, and to ignite them on the outer surface of the jet. The ignition raises the temperature of the whole of the jet, and probably dissociates some at least of the hydrocarbon vapours into carbon monoxide and hydrogen. In what form the undissociated hydrocarbon vapours burn it is difficult to conjecture, but the appearance of the flames suggests that acetylene is present. This might conceivably arise from the reaction $CH_4 + CO = H_2O + C_2H_2$. As the temperature of the flame rises, the hydrocarbons are probably all dissociated, and burn as CO and H to CO_2 and H_2O without further change. When the conditions are satisfactory, the flames are opaque and dazzling white in colour for a distance of some 6 in. from the nozzle of the burner, become semi-transparent, and almost violet in colour at the middle of their length, and shade into red at the end. In burning oil which is mixed with water the combustion is incomplete, the violet colour never appears, and the end of the flame is dark red and fringed with smoke. In some cases, where water is present in comparatively small quantities, the end of the flame is white, and presents the appearance of acetylene, which may arise from want of sufficient heat in the flame to decompose the hydrocarbons. This has been observed when, although no smoke was formed and the air supply was not more than 20 per cent. above what is chemically necessary for the fuel, the evaporative performance of the boiler was poor, which confirms the existence of a low furnace temperature.

APPARATUS DESIGNED FOR UTILISING LIQUID FUEL.

The "burners" which have been designed for admitting liquid fuel into boiler furnaces, numerous as they are, may be broadly divided into three distinct types. These are :—

1st. Mechanical spray, in which the liquid fuel is forced under pressure through nozzles, made of such a form as to break it up into a fine spray and thus render it inflammable.

2nd. Spray burners, where the liquid fuel is held in suspension and driven into the furnace by means of a jet of steam and compressed air.

3rd. Vapour burners, in which the liquid fuel is volatilized and the vapour admitted to the furnace.

ARRANGEMENT FOR SEPARATING WATER.

In addition to the actual burning apparatus, no installation can be considered complete without (*a*) some form of filter to cleanse the fuel oil of impurities, and (*b*) some arrangement for separating water. This last is by no means so simple as it would at first sight appear. The specific gravity of most fuel oils is about 0·92 to 0·96, so that separation by the action of gravity alone is an exceedingly lengthy process and practically never complete ; but as the coefficient of expansion of fuel oil is considerably higher than that of water, the action may be greatly hastened by heating the contents of the tank ; the combination of oil and water, however, is curiously intimate, and a careful experiment showed that at a temperature of 140° F. seven days elapsed before the water was completely separated. A large expenditure of heat is required if the contents of the fuel tanks are to be maintained at such a temperature, and it is obvious that, unless the separating process is complete and the water is all drained out of the tank before any of the fuel is drawn off for use in the burners, the lower layers, which are the first to flow, are formed of a concentrated intermixture of oil and water. One way out of this difficulty consists of a swing pipe supported at one end by a floating vessel. The orifice of the pipe is arranged at a suitable distance below the surface of the liquid fuel, and a coil of steam pipe is fitted so as to raise the temperature of the oil immediately surrounding the opening into the pipe ; the fuel passes through the swing pipe on its way to the burners, and is to a great extent freed of water at a comparatively small heat expenditure.

ACTUAL RESULTS OBTAINED.

It is obviously impossible to draw any exact comparisons between solid and liquid fuels without complete trials carried out in such a way as to show the actual boiler performance, and there are unfortunately no available data which allow of this being done properly from a scientific point of view. Commercially, however, the results have some value, and to make the comparison as [illegible] as actually ascertained is given in four cases :—

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C. F. [illegible]	[illegible]	[illegible]	[illegible]	7,560	2,200
Sithonia	Howden	[illegible]	[illegible]	—	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	—	[illegible]	800
[illegible]	[illegible] [illegible] [illegible] & Co.	[illegible]	[illegible]	2,700	[illegible]

Differences in consumption in favour of liquid fuel as compared with coal :—

C. F. [illegible]	say 27 per cent
Sithonia	28·6 „
[illegible]	30 „
Khodoung	35·5 „

All the vessels have triple-expansion engines of normal proportions except the *Sithonia*, in which quadruple expansion machinery is fitted, and from the coal consumption trial the amount of water required per i.h.p. must be considerably less than in the other vessels referred to.

SOME EXPERIMENTS ON STEAM ENGINE ECONOMY.

THE object of this paper, contributed to the Institute of Mechanical Engineers by Professor R. L. Weighton, was to record the results of two separate and distinct sets of experiments bearing upon the economical performance of the steam-engine. The first constitutes a series of experiments made with a view to determine the economical effect of reheating the steam passing through the receiver of a double-expansion or compound engine. The second forms a series of experiments made with a view to determine the influence upon economy of degree of vacuum in the condenser of a triple-expansion engine. Both sets of experiments were made upon the experimental engines in the Engineering Laboratory at the Durham College of Science, Newcastle-upon-Tyne, and form part of a systematic course of research work upon the steam-engine which is being carried out there. The results, in tabular form, are appended :—

RESULTS OF RECEIVER REHEATING TRIALS

Cylinders $\frac{7 \text{ and } 15\frac{1}{2}}{18''}$ Boiler Pressure 200 lbs (above atm.) Jacket Steam off. Cut off in L. P. Cylinder 7″.

Power varied by shifting H.P. Eccentric. Condensing Water adjusted for an approximate Vacuum of 24·4″.

No. of Trial ..	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
Date of Trial [illegible]	[illegible]	[illegible]	April [illegible]	April [illegible]	[illegible]	May [illegible]	May [illegible]	[illegible]	[illegible]	May 25.
Reheater Steam [illegible]	off	[illegible]	[illegible]	on	[illegible]	on	off	on	off	on
Shift of H.P. Eccentric .. inches	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	½	½	[illegible]	[illegible]
Pressure in H.P. Steam Chest lbs. above atm.	[illegible]	[illegible]	107	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pressure in Reheater Coils [illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	0	[illegible]
Pressure in Receiver [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	36	16·7	[illegible]	1·0	4
Barometer .. .. inches of mercury	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	29·9	29·9	29·75	[illegible]
Vacuum .. .. .. „ „ „	[illegible]	[illegible]	24·4	24·37	[illegible]	[illegible]	24·42	[illegible]	24·2	[illegible]
Mean Pressure [illegible] L.P. Cylinder lbs. per sq. inch	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	30·8	[illegible]	[illegible]	[illegible]
Revolutions per minute	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Condensation in Receiver lbs. per hour	95	[illegible]	not taken	not taken	[illegible]	[illegible]	[illegible]	32·6	would not drain	would not drain
Condensation in Coils of Reheater .. lbs. per hour	[illegible]	[illegible]	[illegible]	106	[illegible]	[illegible]	0	[illegible]	[illegible]	22
Total Water used .. lbs. per hour, W.	[illegible]	2454	2050	2216	[illegible]	[illegible]	[illegible]	1378·6	[illegible]	[illegible]
Steam shown by Indicator Cards at L.P. cut off in percentage of total water	[illegible]	[illegible]	68·4	[illegible]	[illegible]	[illegible]	60	[illegible]	[illegible]	[illegible]
Indicated Horse Power ..	[illegible]	[illegible]	118·7	[illegible]	[illegible]	[illegible]	[illegible]	75	[illegible]	[illegible]
Brake Horse Power	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	67·7	[illegible]	[illegible]
Mechanical Efficiency	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	·911	[illegible]	[illegible]	[illegible]
Pounds Water .. .. per I.H.P. hour	[illegible]	[illegible]	17·2	[illegible]	[illegible]	17·62	[illegible]	[illegible]	21·06	[illegible]
Pounds Water .. .. „ B.H.P.	[illegible]	[illegible]	18·2	18·92	[illegible]	[illegible]	[illegible]	20·36	24·67	[illegible]

NOTES.—1. Trials were made in *pairs*—steam off and steam on Reheater—one after the other with a sufficient interval.

2. The Brake Scales were adjusted for the first trial of the pair and were not altered for the second trial of the pair.

3. In plotting the results on Fig. 2, Plate 2, the Powers in Nos. I. and II. are brought up to the average vacuum of [illegible] 24·4 inches.

RESULTS OF VARIABLE VACUUM TRIALS.

Cylinders $\frac{7'' \cdot 10\frac{1}{2}'' \cdot 15\frac{1}{2}''}{18''}$. Jacket Steam off. Receivers drained continuously.

Cut off in each Cylinder 10½". Brake Sluices shut 1 inch.

No. of Trial	I.	II	III.	IV.	V.	VI	VII	VIII.	IX
Date of Trial, [illegible]	Mar. 14.	Feb. 28.	Feb. 28.	Feb. 28.	Mar. 7.	Feb. 21.	Feb. 21.	Feb. 21	Feb. 21.
Vacuum inches of mercury	[illegible]	11·53	10·70	10·[illegible]	20·40	21·70	24·07	25·72	28·18
$\frac{\text{Condensing Water}}{\text{Feed Water}}$		5·7	7·0	8·4	8·3	8·7	11·2	15·3	43·7
Barometer	29·7	29·78	29·15	29·15	29·7	29·78	29·85	29·85	29·85
Pressure in H.P. Steam Chest (above atm.)	147	146	147	148	147	151	150	148	149
Revolutions per minute (R) .	109	118·6	122·6	124·8	124·3	125·4	126·6	127	127
Indicated Horse Power	51·7	70·2	76·9	78·7	78·5	81	83	82·2	83·4
Brake Horse Power	48·3	60·3	64·9	67·4	66·9	69·1	70·6	71·1	71·5
Mechanical Efficiency	·882	·859	·844	·856	·852	·853	·850	·865	·857
Total Water used per hour in pounds. (W)	1048	1141·5	1187·5	1210	1218	1217	1235	1246	1247
Hotwell Temperature °Fahr. (t_H) ..	212	163	177	164·5	164·3	157	142·8	129·2	88·8
Mean Pressure reduced to Low pressure Cylinder (M)	29·75	35·[illegible]	37·43	37·41	37·33	38·22	38·85	38·32	38·85
I.H.P. at 120 Revolutions. (I) .	[illegible]	71	75·2	75·8	75·7	77·5	78·7	77·6	78·8
B.H.P. at 120 Revolutions. (E) ..	53·2	61	63·5	65	64·6	66·1	67	67·2	67·6
Water per Hour at 120 Revolutions $(W_1) = \frac{120\ W}{R}$	1154	1155	1164	1166	1175	1164	[illegible]	1177	1178
Heat Units per Hour at 120 Revolutions.* $(W_H) = \frac{W_1 (T_1 - t_H)}{T_1}$	954	973	[illegible]	1068	1016	1015	1033	1053	1092

* T_1 = Total heat—above zero Fahr.—per lb. of steam of boiler pressure. (W_H) = Heat units reduced to lbs. of water for comparison.

RUSSIAN RAILWAY ENTERPRISE IN CENTRAL ASIA.

THE *Monthly Review* for August contains an able article from the pen of Mr. R. E. C. Long, on the new railway which the Russian Government have decided to construct between Orenburg, an important town in South-East Russia, and Tashkend, the centre of the most fertile district of Central Asia, situate about 300 miles from the Afghan frontier. The writer points out that the importance of this new project has been somewhat overlooked in England, and describes its political significance as of far greater moment to British interests than the recently completed trunk line which has linked Port Arthur with the capital of the Empire.

The new railway follows the natural and historic path of advance in Central Asia, keeping closely almost for its whole length to the still-existing track which before the opening of the Transcaspian line was the main artery of trade. The only considerable engineering difficulty met with is the bridging of the Ural River at the beginning of the line. From Orenburg the line runs east to Orsk, and there turns to the south, running between two outlying spurs of the Urals, through the Kirghiz country to Irghiz. At Irghiz is crossed a branch of the Turgai River, and thence the railway runs along the road to Kazalinsk on the Sir Daria, actually touching the north-east coast of the Sea of Aral. At Perovsk the line diverges eastward from the road, touching it again by a southward bend at Fort Julek, after which it runs straight to the town of Turkestan. . . . No part of the country traversed, except the last part, is very fertile. But the railway will not only bring supplies both to and from the districts through which it lies, but it will also tap the whole fertile valley of the Oxus; goods sent from the Oxus valley being put upon the railway where the line touches the north-eastern coast of the Sea of Aral. The railway will, therefore, facilitate communication with Khiva and the Oxus valley, as well as with the Sir Daria valley and Ferghana.

It appears that there was an alternative route proposed for the new railway through Central Asia, which was only finally abandoned in 1900. It was to have started from Saratov, on the Volga, running in a direct line across the Caspian depression and the Ust-Yurt plateau to Kungrad and Khiva, and thence as far as Chardjui. Though this latter project would undoubtedly have solved the problem of intercommunication as well as the present line, there were many advantages peculiar to the Tashkend route which could not be neglected. It will be safe from the attacks of the semi-subdued tribesmen, and presents none of those difficulties in regard to water-supply and protection from sand which would have been met with in the desert south-east of Saratov.

But perhaps the greatest advantage of the new line lies in the fact that it will provide, although not by a very direct route, intercommunication between Central Asia and Siberia. . . . At the present time it is practically impossible to transport the surplus Siberian products [illegible] Central Asia. Siberian products must first be sent several thousand miles by railway to Samara, after which follow a second journey of a thousand miles down the Volga, a sea voyage across the Caspian Sea and a third journey of a thousand miles along the Transcaspian railway.

It is expected that the new line will especially stimulate the cotton-growing industry in Central Asia, which has hitherto failed to find room for expansion owing to the difficulties of transport just referred to. In this lies the chief commercial hope of Russia's new undertaking.

The culture of cotton in Central Asia within recent years, and particularly since the introduction of the American plant, has attained enormous dimensions. During the last sixteen years the area devoted to cotton has increased from 1,200 to 375,000 acres, and in 1900 Russia received from her own possessions 7,500,000 bales, or nearly half the amount required for the home manufactures. . . . Cotton, moreover, is one of the few manufactures in which Russia is likely to compete with Western Europe in foreign markets, and an increase in the quantity of cheap material available would probably result in such a development of the manufactures as would drive all competition out of China and Persia.

Mr. Long regards the new railway as likely to be procreative of many important developments, among which the first would probably be branch lines into Eastern Turkestan and Western China.

The English commercial interest in the railway, however, will only begin when the inevitable connection with Indian railways is accomplished. It is hardly to be expected that the Indian authorities will continue for ever to suffer from the blind panic which prevents them welcoming a measure approved of by nearly every authority who has not been blinded by Russophobist dread. The Channel Tunnel (in essence a very similar project . .) was killed by insular panic ; but it is safe to say that had any other nation been concerned, Englishmen would have been the first to turn into ridicule such a dog-in-the-manger policy. . . . It is obvious, also, that if the Russians are intent upon attacking us in India, their plans must be on such a vast scale that the contemporaneous laying of a military railway will be but a detail.

After discussing the strategical value to the Russians of a possible through communication between Moscow and our Indian Empire as a means of invasion, the writer concludes :—

Friendship with Russia can be established and confirmed only on the basis of an adjustment of the mutual relations of the two Powers, without regard to the shifting play of hatred and amity which goes on all over the rest of Europe. The creation of the railway from Central Russia to the Afghan and Indian frontiers is a factor in these mutual relations which needs adjustment, and whether it means bad relations springing from apprehension, or good relations based upon an understanding, depends upon ourselves alone.

THE PANAMA CANAL.

ITS COMMERCIAL VALUE TO THE UNITED STATES.

MR. BENJAMIN TAYLOR contributes to the *Monthly Review* an article on the Panama Canal, entitled "The Wedding of the Oceans." He emphasises the fact that the Suez Canal offers no basis of comparison to those who would accurately forecast the future of the new canal.

The canal will doubtless be of more strategical value to the United States than of commercial value to any of the nations ; but it will also be of more commercial value to the United States than to any other nation. Whether it will be of any great commercial value to Great Britain, or whether we shall derive any benefit at all from it except in the general enlargement of the world's commerce may be open to doubt. In its commercial aspects a canal across Central America, at any point, is strongly differentiated from the one across Suez. The Suez waterway connects two vast and thickly populated land areas ; the Panama Canal will connect two wide oceans. East of Suez are the teeming millions of Asia, waiting with their produce for the markets of Europe ; west of Suez are the workshops of the world. East of Panama is the broad Atlantic, separating the canal from the workshops and markets of Europe ; west of it are 6,000 miles of ocean, sprinkled with a few unconsidered insular trifles. Those who attempt to deduce from the experience of Suez a forecast of the future of Panama cannot fail to get far astray. There is no basis for comparison, even with a canal through Nicaragua, which would have passed through a region capable of development and of furnishing some local traffic.

WHERE THE UNITED STATES WILL SERVE.

He thus summarises its value to the United States :—

But in the case of the American canal, if, instead of looking east and west, we look north and south, a different prospect presents itself. The waterway will connect the busy workshops of the Eastern States of North America with the hobbledehoyish, but potentially industrious, Republics of the western side of South America. It will also connect the Pacific States of North America with the Eastern Republics of South America, though it is doubtful if much interchange of traffic will result. California and Argentina are competing wheat and meat producers, and neither country has much else that the other wants. The main point is that the commercial wants of the western side of South America are at present almost exclusively supplied from Europe ; in future they will probably be supplied from the United States, when the canal brings them a few thousand miles nearer together. Again, it is expected, and with some show of reason, that when the canal is completed every pound of cotton required by the growing industries of Japan will be supplied from the Southern States of the American Union. And there can be little doubt that the coal of West Virginia and the iron of the Southern States will have opened up to them wide markets from which they are at present shut out.

ITS BENEFIT TO BRITISH TRADE.

This, says Mr. Taylor, is problematic :—

The extent, as we say, to which British trade will benefit by the canal is very problematic. For Europe generally the gain will be a nearer route to the Pacific shores of North and South America, to the South Sea Islands, and to New Zealand. To Canada the canal will ultimately be of first-rate importance when she is more industrially developed. At present, however, her exports are mainly agricultural, and find their market almost entirely in the United Kingdom or the United States.

The reduction in distances is all in favour of the United States ; but the change in many instances produces a complete reversal of the advantage which British trade at present enjoys. By the Suez Canal England is closer than the United States to Australia, China, and Japan by about 2,700 miles. When the American canal is built, the cities of the Atlantic seaboard of North America will be only 1,000 miles farther than this country from Hong-Kong and Central China ; and they will be upwards of 1,200 miles nearer the northern ports of China, Korea, and Japan, 2,700 miles nearer to the western ports of South America, 1,300 miles nearer to Melbourne, and more than 3,000 miles nearer to New Zealand. The Atlantic termini of the Nicaragua and Panama Canals are about 300 miles apart, but are about the same distance from New York. For certain ports each route is shorter than the other, but for the traffic as a whole the difference in sailing distances is unimportant.

Although it is not too much to predict that the whole world will benefit by the opening of the canal, the present writer adheres to the opinion he has before expressed, that the commercial value of such a waterway has been exaggerated.

THE NAVY AND THE ENGINEER.

THE condition of the engineering branch of the Naval service is the subject of a further article in the *Monthly Review* for August. Mr. Carlyon Bellairs, whose defence of the Admiralty's position appeared in the May number of that journal, has again taken up the cudgels in reply to Mr. D. B. Morison's vigorous answer to Mr. Arnold Forster's statements in the House of Commons during the debate on the Naval Estimates. This second article, however, is a long way behind the one that appeared in June, and may be said to be somewhat weak and inconclusive.

The following excerpts will give our readers an idea of the strain in which the article is written :—

It is regrettable to find, in the threatening language used by the civil engineering associations, indications that what is sought is the power of enforcing advice, to be exercised by men partially acquainted with the internal economy of a navy, and who have no idea of the relations of their special sphere to the whole.

It is evident that engineers think too much on the surface, or they would not argue that a mistake here and there is a sufficient cause for revolutionising the system under which the Navy has always been governed. The bias of the mechanical mind is that, dealing with easily ascertainable causes and effects, formula and routine methods, it believes that all difficulties are capable of solution with mechanical precision. Then, when argument fails, discredit is thrown on the Admiralty, and Lord Selborne is represented as a puppet.

The engineer is received into the wardroom on his own merits. If here and there, as is the case with military officers, the social status is beneath that of other officers, and it is necessary to make it equal, the nomination system must be introduced, as in the executive and accountant branches. There will be no lack of desirable candidates if a better balance between the lower and higher grades is effected by the reduction of the number of entries and the substitution for watch-keeping duties of the artificer-engineers.

The note at the end of the article is probably the most interesting. It runs as follows :—

A strong contention has been put forward that the number of engineer officers on board British ships is dangerously insufficient. It is, unfortunately, impossible to give comparative figures of artificers, but the following figures in parentheses give the number of engineer officers in typical ships in the principal navies : British battleships, *Renown* (7), *Ramillies* (8), *Canopus* (7, exclusive of an inspector of machinery for service with the fleet), *Cæsar* (6) ; French battleships, *Saint-Louis*, *Charlemagne*, *Gaulois*, *Bouvet*, and *Jauréguiberry* (4 engineer officers each). The German *Wittelsbach* (5) ; the Russian *Poltava* (7) ; and the American *Wisconsin* (5). Turning to typical first-class cruisers, the numbers are : British, *Kent* (7) ; French, *Gueydon* (4) ; German, *Furst Bismarck*, (4) ; Russian, *Bayan* (6) ; and American, *Brooklyn* (5). I think that these figures must give pause to the civil engineering agitators who so often expose themselves to such complete refutation as to induce the belief that they are the bad workmen of their profession, for they start cutting without feeling the edge of their tools.

REVIEW OF LEADING CONTINENTAL PAPERS.

A Monthly Review of the leading papers read before the various Engineering and Technical Institutions of the Continent.

IRON METALLURGY AT THE DÜSSELDORF EXHIBITION.

THE Düsseldorf Exhibition is so much the more interesting and remarkable as it represents the industry of only two German provinces, the Rhine and Westphalia, with neighbouring districts; but at the same time it must be borne in mind that these two provinces contribute a very important contingent to the German production of pig iron and finished iron and steel. As German ironmasters did not obtain sufficient space at the Paris Exhibition of 1900 to make a display worthy of their industry, they preferred to reserve their forces for that now being held at Düsseldorf; and they have succeeded beyond all possible expectation. These remarks are made by M. Alexandre Gouvy, formerly manager of the Alais Ironworks, and subsequently of some steelworks in Russia, who has made a profound study of the metallurgical exhibits. He has recorded the results of his observations in an exhaustive communication to the *Société des Ingénieurs Civils de France*, and has made an abstract of the same for the *Association des Ingénieurs de Liége*, from which a few salient points are here noted.

KRUPP PAVILION.

The first steam engine erected at the Krupp Works finds a place by the side of the most powerful modern engines, an armour-plate weighing 106 tons, a hollow lay shaft, 45 metres (147½ ft.) long, weighing 52 tons, and the most varied steel castings, including some of extra hard quality. A railway waggon made of pressed steel has a carrying capacity of 40 tons for a dead weight of only 13·6 tons; and the roll-train that turned out the 106-ton armour plate has rolls 4 metres (13 ft.) long.

HOERDE PAVILION

The chief exhibits of this company are spare shafts for the 500-horse Oechelhäuser and 1,000-horse Otto-Deutz gas engines for the electric generating station at the works; a plate weighing 9·8 tons and another weighing 8·15 tons; a rail, 76 metres (250 ft.) long, weighing 3·116 tons, that forms a hand-rail in the middle of the pavilion; steel castings, with very hard surface made by the Hunt process with rotary moulds, and pressed plates for the frames of waggons and locomotives.

THE BOCHUMER-VEREIN

shows crucible cast-steel bells; an enormous cast-steel stern post for a twin-screw steamer, 15 metres (49 ft.) high and weighing 87 tons; a converter ring weighing 18 tons; a partially finished cast-steel cylinder for a 5,000-ton hydraulic press, absolutely free from blow-holes although weighing 34 tons; cast-steel locomotive wheels, and the crank-shaft of a 1,500-horse gas engine.

THE EHRHARDT PAVILION

is chiefly distinguished for the large cylinders rolled without weld at Reisholz by a special method, which Herr Ehrhardt has only brought to perfection after long and costly trials. The parts are shown in the various phases of manufacture, from the ingot pierced and drawn out under the hydraulic press to the finished cylinders rolled in a special train, with the upper roll oscillating and adjustable during the operation. In this manner cylindrical bodies are formed 3·5 metres (11½ ft.) long, and having a diameter of more than 2 metres (6 ft. 6¾ in.).

THE GUTEHOFFNUNGSHUTTE, OBERHAUSEN,

exhibits a 1,000-horse four-cylinder Otto gas-motor, driving, by a prolongation of the fly-wheel shaft, two air cylinders fitted with Corliss inlet valves and Stumpf delivery valves, these blowing cylinders having been installed by the engineers of the Oberhausen Works, where a great many Otto engines have for a long time been working with blast-furnace gas.

THE MACHINE HALL

contains a most interesting collection of iron-works appliances, especially motors for working with blast-furnace gas, although at the exhibition this is replaced by producer gas, the types represented being—

1. The 700-horse two-period Oechelhäuser motor, driving a blowing cylinder that draws in 500 cubic metres (17,658 cubic feet) of air at 100 revolutions per minute, and delivers it at a pressure of 0·54 kilogrammes per square centimetre (7½ lbs, per square inch). This motor is distinguished by having two pistons arranged back to back in one and the same cylinder, without special parts for admission or delivery, the pistons themselves uncovering the orifices; but, on the other hand, the mixture of air and gas is effected by a special compressor, the contrary motion of the pistons requiring a fly-wheel shaft with three cranks.

2. The 500-horse two-period Körting motor, which also works a blowing cylinder for 500 cubic metres (17,658 cubic feet) of air at 100 revolutions per minute, delivering it at a pressure of 0·4 kilogramme per square centimetre (5½ lbs. per square inch), this cylinder being fitted with Corliss inlet and Stumpf delivery valves.

3. A second Körting motor of 700 h.p., driving a three-high roll-train for medium size rails, this being the first rolling-mill that has been made to work by a gas engine. The Körting motor is that which of all gas engines most nearly resembles the steam engine in general appearance, the gas and air compressors (arranged laterally) having the appearance of the cylindrical slide-valves of an ordinary engine. There are only valves for the admission, the exhaust being effected by orifices uncovered by the piston. This double acting piston, working in a single cylinder closed at both ends, would cause difficulty with unpurified gas. This however, is obviated by its purification.

4. Louis Soest and Co. show a 300-horse four-period motor, which has been designed to turn to account the experience gained with other motors. While all the parts are easily replaced, wear is reduced to a minimum and all the working parts are kept cool.

COLLECTIVE MINE EXHIBITION.

Here may be found self-charging boilers, a Weiss central condensation arrangement, a Tigler briquette press at work, and also various fans and pumps. The large Haniel and Lueg underground pumping engine is designed to raise 25 cubic metres (5,500 gallons) per minute to the height of 500 metres (1,640 ft.). Opposite the large Humboldt-Kalk headgear is an original winding engine, with vertical compound cylinders, the pistons of which work, by rods and triangular levers, two conical half-drums; and near it is a compact electrical winding engine, capable of raising a useful load of 4·2 tons at a speed of 20 metres (65½ ft.) per second.

WIRELESS TELEGRAPHY.

THE problem to be solved is thus stated by M. Victor Thiran: To send through space, by means of a small transmitter, signals that can be received at the greatest possible distance by suitable apparatus, without the sending and receiving stations being connected in any manner; and he divides the attempts made to solve this problem into four categories, in relation to the experiments which have been made with sonorous, luminous, electro-magnetic or electric waves, passing rapidly over the first three, but dealing at greater length with the solution by electric waves, which alone appear calculated to afford a complete solution of the problem.

After recounting to the *Society of Hainaut Engineers* the experiments of Hertz, Popoff, and Marconi, the author described those with very compact appliances by M. Ducretet, of Paris, whose signals, sent from the Eiffel Tower to the Panthéon, a distance of 4 kilometres (2½ miles), were received with perfect distinctness. In Belgium conclusive experiments were made between La Panne and the mail steamer *Princess Clémentine*, for a distance of 80 kilometres

(50 miles); and messages sent from Brussels were received accurately at Malines, or Mechlin, while those in the reverse direction were indistinct, owing, it is supposed, to the masses of metal at the receiving station, the Colonne du Congrès, as indeed was also the case with the return messages sent from the Panthéon to the Eiffel Tower.

Notwithstanding the important results obtained, several gaps still remain to be filled. The transmitting instrument sent signals in all directions, each one of which could receive them; and in the event of there being several stations along a given radius, all the signals mingled and became confused. Moreover, it is evident that, for extending the distances to be traversed, the length of the antennæ cannot be increased indefinitely, any more than can the power of the coils employed. Accordingly, a legion of inventors endeavoured to realise these various improvements, and proposed a great many methods; but those that have been subjected to practical trials are for the most part founded on the principle of "syntonisation," *i.e.*, imitating the acoustic phenomenon of resonance.

Marconi has succeeded in greatly reducing the height of the antennæ necessary, and has transmitted signals to a distance of 50 kilometres (31 miles), with antennæ consisting of hollow cylinders, only 1·25 metres (4 ft.) high and 40 centimetres ($15\frac{3}{4}$ in.) in diameter. His experiments also tend to prove that he is very near solving the problem of syntonisation. By electrically "tuning" his transmitting and receiving instruments so that the latter can only be influenced for waves of determined length, and solely by them, he has succeeded in operating ten transmitters connected with one and the same antenna, each sending its message to one only of ten receptors placed side by side, and also utilising a single receiving antenna.

According to Guarini and Poincaré, this system is incomplete, because Thomson's formula, on which it is founded, applies only to the principal oscillation, taking no account of secondary oscillations, the effects of which may be felt to a distance of 20 kilometres ($12\frac{1}{2}$ miles). With this system multiple and simultaneous telegraphy would be impossible in both directions, because the receiving instruments must be at least 20 kilometres ($12\frac{1}{2}$ miles) apart, in order not to be influenced by the corresponding transmitter.

Guarini endeavours to ensure the secrecy of a message in a manner different from that of Thomson. The electric waves emitted by the antenna of the transmitting station radiate normally to its surface and in all directions. By means of a longitudinal slit in the metal sheath of a carefully insulated wire, Guarini restricts the electric radiations to a narrow pencil, or series, which he transmits to the receiving antennæ, so arranged as to receive none but the radiations emitted by the transmitting station; but it is evident that all the stations comprised in the direction of the pencil, or series, can receive the messages intended for another station.

The Slaby-Arco system, which enjoys a certain amount of favour in several countries, differs from that of Marconi in the connections of the antennæ. In the latter system there is an open circuit between the top of an antenna and the earth, while in the Slaby-Arco system the circuit is closed by the earth, since the summits of the transmitting and receiving antennæ are in communication with the soil; and in addition the Slaby antenna is constituted by a mass of metal wires.

In fine, the progress made since the first practical attempts at wireless telegraphy in 1897 has been enormous; and the author concludes that electric waves will before long form an invisible network of vibrations round the world.

GOLD IN THE SALONIKI REGION.

Of all the regions in European Turkey, certainly that of Saloniki most interests the geologist, while recalling the grand phenomena of past ages. The glacial period here exerted intense influence; and there are few hills or mountains that do not bear ineffaceable evidence of the passage of the "grands laboureurs," while the insignificance of the erosive phenomena has preserved this evidence almost intact from the most remote period to the present day. No vegetation interferes with geological research, and no violent erosion suggests a wavering of the judgment, while the glacial deposits have scarcely suffered the ravages of time. The few streams which flow through them have simply worn a shallow bed, the banks of which, generally vertical, permit of easily studying the nature and intimate constitution of the deposits.

Thus opens a communication to the *Société de l'Industrie Minérale* on the glacial formations and auriferous deposits of the Saloniki region, by M. François Blanc, who observes that it will be readily understood how interesting is a geological study under such conditions, very rare in Europe, where erosion daily pursues its work of destruction. In the Saloniki region the erosive phenomena characterising epochs later than, or contemporary with, the glacial period have suddenly ceased; and since the most remote times the streams have but little worn away their banks. The region under notice may be regarded as a vast circle of about 100 kilometres (62 miles) diameter, bounded by high mountains, but open to the sea on two sides—to the south-west on the Gulf of Saloniki, and to the south-east on that of Orfanio.

GEOLOGICAL DESCRIPTION.

The primitive rocks (gneiss, schist, and mica-schist) predominate, constituting all the mountain masses. At no point have there been found to exist sedimentary deposits anterior to the tertiary epoch, except, perhaps, at Makukovo, where carbonaceous shales and sandstones may be perceived at places in the beds of the streams, overlain by deposits of glacial origin. The chief eruptive rocks are the peridotites, which make their appearance at several points, especially along a well-determined line; and a considerable trachytic peak has been noticed at Dohantza.

It is very remarkable that limestone has not been found in the Karadagh mass; and to this exceptional fact is due the possibility of reconstituting the successive periods of the glacial invasion which at a given moment covered the region. Another no less remarkable fact is that all the alluvia, or deposits of whatever nature, issuing from the Karadagh are auriferous, whence it happens that, whenever alluvia or deposits free from calcareous elements occur in the Saloniki region, there is a certainty of their being auriferous. These two facts confirm one another, and have permitted of synthetically studying the geology of a whole region, if this expression be permissible; and, indeed, they permit at points even far distant of characterising the origin of alluvia and of tracing them to their source. Such a study is possible under these circumstances, and will permit of reconstituting, from their track or the *débris* evidencing their passage, the ravages of the "great ploughmen."

THE GLACIAL DEPOSITS.

It may be said generally that in the circus comprised within the Rivers Vardar and Karasou, the Gulf of Saloniki and the Kortiatch chain, deposits of glacial origin cover all the points where primitive rocks do not crop out; and these deposits chiefly occur in the western portion of the circus, the middle being almost entirely free from them. In the Klkch region their intensity is such as to escape all analysis, only permitting the casual observer to form uncertain hypotheses as to their origin; and to find them with their true characteristics they must be studied in the immediate neighbourhood of Saloniki. A study of the different glacial deposits in this neighbourhood has led the author to assign them a common origin, and has demonstrated the existence, at the glacial epoch, of an immense glacier which came into contact with the Kortiatch chain and passed it at all the indentations, thus sending numerous ramifications into the present plain of Saloniki.

AURIFEROUS DEPOSITS.

It may be said that, as a rule, in the whole perimeter comprised between the Rivers Vardar, Karasou, and its tributary, the Boutkova, and the Langaza depression, there is not a stream that does not carry down gold-bearing sand. In these regions gold occurs in the form of dust and also of nuggets; but the latter are only found at certain points, while their weight has never been known to exceed 20 grammes ($\frac{2}{3}$ oz.). As to the dust, which constitutes the greater portion of the gold collected by the inhabitants, it is very fine, readily floating in the cradles, and thus rendering even an approximate estimation of the richness of the sand especially difficult.

Nor does washing with the sluice afford any better indication. Owing to the large quantity of magnetite in the sand, the spaces at the bottom of the sluice, where the gold should accumulate, are soon filled up; and, when this takes place, the tenuity of the gold does not permit it to lodge there free from the action of the current. It thus happens that a sample weighing a ton shows scarcely any more gold than does one of 2 cwt.; and this circumstance explains the fact that the gold wealth of many rivers is approximately the same over the whole length of their courses.

There is also little certainty as to the gold content in the alluvium constituting the high terraces. Some analyses have shown 5 grammes (⅙ oz.) to the ton; but it is more probable that the real content does not attain half that figure. Considering the enormous extent of the alluvia, their slight cohesion, and their uniformity as regards richness, such a content may permit of remunerative working; but the treatment must be appropriate to the physical state of the gold. Methodical prospecting may also afford the chance of finding rich places in the region of the Karadagh, nuggets of 20 grammes (⅔ oz.) having been found at various points. To be of any use, explorations should be carried to a certain depth, because the presence of old workings leaves little chance of finding virgin alluvia at all rich near the surface. On the whole, concludes M. Blanc, the whole region of the Karadagh affords a vast field of exploration to future prospectors.

NEW EJECTO-CONDENSER.

INVENTED by Alexander Morton, of Glasgow, in 1867, nine years after the Giffard injector, of which they are a generalisation, the ejecto-condensers were perfected and brought out chiefly by the Brothers Körting. In these appliances the motive fluid, steam, arrives by an annular pipe surrounding the induced jet of water: and Professor Boulvin describes them as Giffard injectors taking their motive steam from the cylinder and delivering at atmospheric pressure.

As explained to the *Société de L'Industrie Minérale* by Professor Rateau, his ejecto-condenser consists, like the others, of three distinct parts, viz., (1) the convergent nozzles, by which arrive the two fluid currents, one of them, annular, surrounding the other; (2) the mixer, in which the steam, outside the water, becomes condensed on contact with the water, with a considerable change in the mean specific weight of the fluids; and (3) the divergent diffuser, in which the speed of the whole current issuing from the mixer is reduced and partially transformed into useful pressure, the diffuser being connected with the mixer by a throttled section called, by the inventor, the neck.

CHARACTERISTICS OF THE NEW FORM.

The new ejecto-condenser is characterised by (1) its injection pipe, which gives the jet a special form, ensuring rapid condensation of the steam; (2) a regulating of the water volume; and (3) a special arrangement of retaining valve. The injection pipe, a cross section of which has the appearance of a star with several rays, delivers a jet of water divided into thin sheets, the perimeter of which is about three times that of the full circular jet corresponding with the same volume. The special regulating arrangement permits of varying the water volume in accordance with the power of the engine, whereas in all previous injecto-condensers the expenditure of water is constant whatever be the quantity of steam. The retaining valve, which is hollow and bi-conical, prevents the water from entering the cylinder during stoppages.

THE THEORY OF EJECTO-CONDENSERS

is founded on the theorem of conservation of the quantities of motion during the shock of the two fluid currents in the mixer; and then, for estimating the pressure which the *vis viva* can overcome in the divergent diffuser, account must be taken, on the one hand, of loss by friction and eddying in this portion of the appliance, and on the other hand of the effects produced by the induced air and the steam, the condensation of which may not be complete when the fluid current leaves the mixer to enter the diffuser.

INFLUENCE OF AIR AND NON-CONDENSED STEAM.

The air which penetrates into ejecto-condensers greatly interferes with their working, as it occasions a reduction in the height of pressure that they can afford, and also a diminution in the vacuum, which would otherwise be perfect. This air proceeds partly from the condensation water, which dissolves about 1·7 per cent. of its volume at ordinary temperatures, but also, and especially, from the exhaust steam, because it is contained in the water for feeding the boilers; and air also enters by the stuffing-boxes and slide-valves, and at the pipe joints, so that at least 4 per cent. must be allowed for it altogether. To the disadvantageous action of the air is also added that of the uncondensed steam; and there is reason to suppose that the steam is not entirely condensed when the fluid current traverses the neck of the appliance. The proportion of uncondensed steam is evidently so much greater as there is more air to interfere with the condensation, and less difference between the temperature of the steam and that of the water on leaving the mixer.

GENERAL LAW.

An experimental determination of this difference leads to results which permit the author to formulate the following simple and remarkable law: For an appliance working under determined conditions of water pressure above and below (up-stream and down-stream), the difference in temperature between the steam and the water is practically constant, whatever be the volume of steam expended.

COMPARISON BETWEEN THE RATEAU AND OTHER EJECTO-CONDENSERS.

A comparison of the curve representing the vacuum obtained by the new ejecto-condenser with that by the condenser of a Corliss engine at the Creusot Works shows that the former appliance affords practically the same degree of vacuum, but that beyond 30 deg. Cent. (86 deg. Fahr.), and as the temperature increases, it becomes more and more inferior. At ordinary temperatures of working, however—*i.e.*, between 30 deg. and 35 deg. Cent. (mean 90 deg. Fahr.),—the difference is slight, being only about 27 millimetres ($1\frac{3}{32}$ in. of mercury). For an equal expenditure of condensation water, therefore, ejecto-condensers afford, under normal conditions, a vacuum practically equal, or at any rate but little inferior, to that obtained with good ordinary condensers.

APPLICATIONS AND ADVANTAGES OF THE EJECTO-CONDENSER.

Although ejecto-condensers may be placed in any position, the vertical arrangement is best, because it favours the action of gravity. They may be applied to any type of engine, especially those running at a high speed. Their chief advantages are simplicity, slight first cost, small space occupied, and especially the absence of delicate parts, so that they cannot get out of order, while they require no attention. Perfect regularity of working may be secured by avoiding the entrance of air and by forcing water into the appliance if it be not under pressure, or by hanging the ejecto a few metres above an evacuation basin, filled with water by natural flow or by a centrifugal pump.

Owing to their simplicity, ejecto-condensers may easily be fitted to small steam engines, even those of 10 to 15 h.p.; and at the same time there is no difficulty in extending their use to large engines, because they are capable of dealing with as much as 20 tons of steam per hour. They are therefore, equally with injection or surface condensers, suitable for the central condensation plants of works and mines; and a single ejecto-condenser will in most cases suffice to deal with the steam of an ordinary pit.

Winding engines and those driving roll-trains stop every minute or every two minutes, when steam admission and exhaust cease; and, when the engines are started again, they discharge a large quantity of steam. Such variations in the exhaust are met perfectly well by ejecto-condensers with water under pressure or a suction pipe; but there must be a constant volume of water, corresponding with that of steam at the maximum, and therefore far greater than that merely necessary for the mean.

It is true that this difficulty may be overcome by adopting M. Rateau's method of automatically regulating the water injection and shutting off the admission during stoppage; but the volume cannot well be reduced by more than half, so that it is preferable to employ his steam accumulator, which, interposed between engine and condenser, transforms the intermittent flow of steam into a continuous flow, and thus permits of determining the volume of condensation water. This simple appliance consists of a cylindrical plate-iron receiver, in which are piled shallow cast-iron basins, for dividing the water into thin sheets; and this accumulator, a veritable calorific fly-wheel, acts as a condenser when it receives a large mass of steam, but as a generator when the engine stops, the alternate condensation and vaporisation corresponding with slight variations of pressure.

Although, concludes Professor Rateau, this combination of the accumulator with the ejecto-condenser satisfactorily solves the problem of condensation for engines working intermittently, it does not afford the perfect combination which he recommends. There is a fourth element which should be introduced between the accumulator and the condenser, viz., the low-pressure steam turbine driving an electric generator; and then will be realised the complete series—boiler, engine, accumulator, low-pressure turbine and condenser, affording the best possible utilisation of the energy afforded by a given volume of steam.

NEW INTENSIVE FURNACE.

IN all existing furnaces the walls and arched roof are smooth, which the Baron Fernand Del Marmol considers a mistake. In November last he brought a model of his new arrangement before the *Liége Engineers' Association;* and during the present year the system has been tried on a large scale, applied to glass and steel melting furnaces, with a theoretical increase of 60 per cent. in the production, though the inventor is satisfied with claiming 20 per cent.

With the present smooth surfaces, the gases of combustion follow them in a parallel direction without mingling; but if the surfaces be made irregular, like a honeycomb, the gases, entering the cavities and then leaving them through the effect of the draught, while taking a diagonal direction, will come into contact with the gases from the middle of the furnace, multiplying the points of contact, favouring combustion and producing a more intense heat with the same quantity of coal.

These irregular surfaces are produced by setting in (or back) every other brick to the extent of half a brick, or by building out (forward) every two or more bricks, so as to produce a checkerwork, which proceeds quite as quickly as the ordinary form of brickwork, and may be executed as cheaply, no matter what be the nature of the furnace.

RESULTS.

It was stated to the Charleroi section of the above-named association that, with a small trial furnace on the new system for melting glass, fusion was effected in from two and a half to three hours, against nine to ten hours in a similar furnace with smooth sides; and in a large steel-melting furnace ingots were treated more rapidly, the high temperature being practically uniform over all the second half of the furnace.

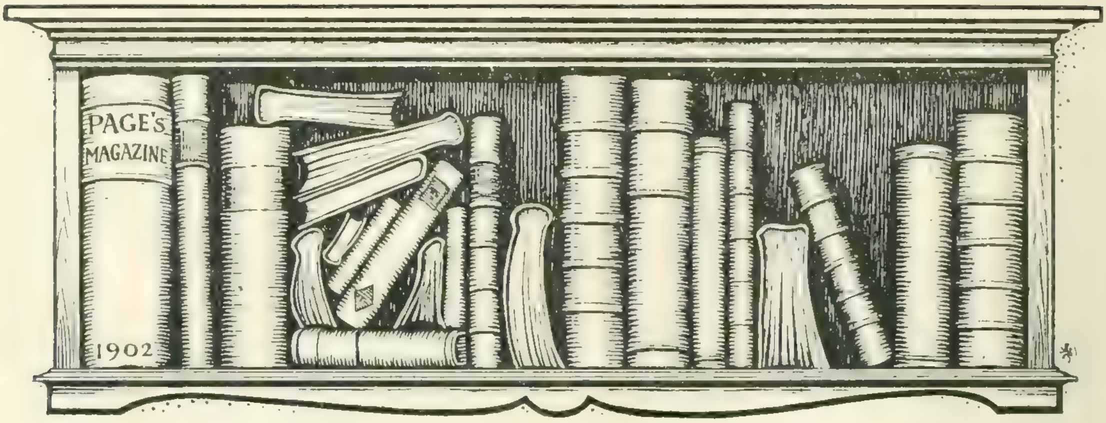
MAINTAINING THE AIR CUSHION IN STEAM PUMPS.

INSPIRED by the Piron hydraulic ram, M. Thiran succeeded in introducing air into the air-vessel of a Tangye steam pump provided with no mechanism for that purpose; and the following description of his arrangement is contained in a paper to the *Société des Ingénieurs du Hainaut*.

A small vertical cylinder attached to the air-vessel is surmounted by two valves, one for drawing in air and the other for delivering it into the air-vessel. The bottom of the cylinder is connected by a pipe with the steam pump in such a manner that it can be influenced by the inlet and delivery valves of the latter.

As the water in the small vertical cylinder forms a piston, when the pump draws in water the lever falls in the small cylinder, the air entering by its inlet valve; and, at the return stroke of the plunger, the air drawn in is forced into the air-vessel through the delivery valve of the small cylinder and the pipe connecting it with the air-vessel. In fact, when the delivery valve opens the same pressure is exerted on the water in the air-vessel and that in the small cylinder, the equilibrium that has a tendency to set itself up between the two levels having the effect of forcing air from the small cylinder into the air-vessel. A small plug-cock, between the bottom of the small cylinder and the pipe connecting it with the pump, permits of regulating as may be desired the quantity of air to be introduced, by accelerating or retarding the motion of water in the cylinder.

Before the adoption of this arrangement all the joints in the delivery pipe of the pump, for a length of 300 metres (984 ft.) gave out each time the pump was started; but since the appliance has been added the joints have lasted the usual time, while the arrangement has the advantage of being simple, inexpensive, and applicable to any pump.



BOOKS OF THE MONTH.

In this department special attention will be paid to all books dealing entirely or in part with subjects within the *purview of the Magazine.* While space will be given for expressions of opinion on books or papers of general interest which may be submitted for that purpose, contributors will please remember that this column is intended in the main for reviews of technical books dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining, and Allied Industries. The address of the publisher and prices should be enclosed in all publications sent for review.

"AMERICAN INDUSTRIAL CONDITIONS AND COMPETITION."

Reports of the Commissioners appointed by the British Iron Trade Association to enquire into the Iron, Steel, and allied industries of the United States. Edited by J. Stephen Jeans. London: Offices of the British Iron Trade Association, 165, Strand, London, W.C.

SOME time ago the British Iron Trade Association decided to send out a Commission to report on the industrial conditions in, and competition from, the United States. The Commissioners included Mr. Axel Sahlin, who reports on pig-iron manufacture; Mr. Enoch James, who takes up general steel works practice; and Mr. E. Parkes, M.P., who deals with sheet and bar-mill practice. The economic and industrial section has been undertaken by Mr. J. Stephen Jeans, who also edits the volume.

It is obviously impossible in a short review to do justice to a volume which extends to some 600 pages, and contains so many maps, diagrams, and illustrations. It may at once be said, however, that it is by far the most comprehensive thing of its kind that has yet been attempted, and one which focusses within reasonable limits all the most important facts and figures relating to the subject with which it deals. Indeed, several of the large works have arranged for the distribution of copies to the heads and foremen of their various departments; and if such officials as these are thereby made acquainted with the conditions they have to face, the volume should render an invaluable and lasting service to British industry. Incidentally it may be remarked that the reception accorded the Commission was most generous. Mr. C. M. Schwab threw open all the works of the United States Steel Corporation, and others were equally courteous.

Mr. Jeans, whose report is by far the largest, attributes the recent remarkable progress of American trade to the low price of raw materials, the low cost of labour measured in terms of efficiency, and the cheapness of railway transport. Mr. Sahlin is in agreement with these conclusions; but, on the other hand, Mr. Enoch James, writing of steel works practice, remarks: "After much consideration the conclusion I have arrived at is that the American workmen do not work so hard as the men in England. . . . They are much more desirous of getting out large quantities." More and closer supervision was noted. Mr. Jeans informs us that private firms are not afraid of the Steel Corporation or Trust. "In every part of the United States," we read, "plants are entering the lists to compete against the Steel Corporation. It has been observed," continues Mr. Jeans, "that the best returns on capital during the 'lean years' were not generally those of the larger enterprises, but those of a few smaller firms." On the subject of trade unions, we learn that "few employers are ready to acknowledge that they have any influence worth naming." Space will not permit us to place this excellent work under further contribution, and we can do little more than give a clue to its varied contents. We recommend it, however, to the serious consideration and attention of our readers.

"SUBMARINE WARFARE, PAST, PRESENT, AND FUTURE."

Grant Richards. 7s. 6d. net.

MR. HERBERT C. FYFE, the author of the article on "Submarine Boats" which appeared in our last issue, has given us in this volume the result of several years' careful study, and has at the same time succeeded in presenting the subject in an interesting and popular form. An introduction has been written by Admiral the Hon. Sir E. R. Fremantle, G.C.B., C.M.G.; and Sir Edward J. Reed, K.C.B, F.R.S., contributes a short article on the probable future of submarine boat building. The latter eminent authority on naval construction thinks that the future development of submarine engineering will be on triple lines :—

> (1) Vessels for the defence of ports and harbours, with sufficient means of proceeding outside to give the defence a certain limited power of attack in the approaches; (2) vessels primarily designed for attack, and therefore capable of proceeding to sea for considerable distances; and (3) smaller vessels to be taken to sea in ships, as part of their equipment, and capable of being lowered to take part in a battle, and raised again, and re-stowed on board when no longer needed in action.

Mr. Fyfe divides his book into three sections: the first deals with the construction of the modern under-water vessel, and its value in naval warfare; the second gives a short history of its development up to the present time; and the third forms a valuable appendix to the whole work. The author's ideal submarine boat has, he remarks, "a speed as great as that of the fastest torpedo-boat, and a very wide radius of action, excellent sea-keeping powers, unlimited quantities of air for power and for respiration by the crew; a means of directing its course by vision upon a moving object whilst itself remaining invisible beneath the surface; and is very habitable and comfortable for long periods."

A chapter is devoted to the discussion of a possible "antidote to submarines." Various defensive projects are described, but Mr. Fyfe is inclined to deprecate their claims to efficiency. "The means of attack against submarines at present are (1) by quick-firing guns; (2) by firing shells full of high explosive, which, bursting in the water near the boat, will beat it in; (3) by firing explosives at the end of a spar." Assuming that a submarine is obliged to rise to the surface to take bearings before attacking a ship, the third method appears to be the one most favoured by the Admiralty, and its value was tested last year by experiments carried out at Portsmouth by H.M.S. *Vernon* and the destroyer *Starfish*. On the starboard side of the latter vessel "certain plates had been strengthened, and above there was a crutch upon which worked a spar or outrigger torpedo . . . a stout pole 42 ft. in length, at the end of which was an explosive charge of 32 lbs. of wet guncotton, explodable by an electric current by the crew in the boat. Normally, this boom stows inboard and forward, but on going into action it is slung out well forward, and immersed in the water at the proper moment. This immersion carries the boom end downward and aft, and it is exploded directly the submarine is passed. The idea is that the speed of the destroyer will carry her past the centre of the explosion before the full effects reach her."

In the appendices, detailed descriptions are given of the new British, French, and American submarines, and the general interest of the volume is enhanced by fifty unique illustrations from drawings and photographs.

"IRELAND, INDUSTRIAL AND AGRICULTURAL."

Edited by William P. Coyne, Superintendent of the Statistics and Intelligence Branch of the Department of Agriculture and Technical Instruction for Ireland. Browne and Nolan, Ltd., Dublin, pp. 532. 5s. net.

IN the forty-nine articles which are comprised in this handsomely produced volume, a clear and lucid survey is given of the various economic resources of Ireland at the dawn of the twentieth century. The subjects have been entrusted to writers who have made their particular sections a very special study, and are eminently qualified for the task. Many of the articles deal with vital matters upon which, up to the present, full and accurate information has not been generally accessible, and with regard to which public opinion has not been sufficiently enlightened. The Editor, while carefully avoiding controversial subjects, has endeavoured to provide a handbook which will give the student an accurate view of the growth, or decrease, and present position of Irish industries and general economy; and this he has succeeded in presenting in an attractive and interesting form. Whilst there are of necessity long and intricate tables of statistics and dry industrial facts, yet in many of the articles these are enveloped in bright descriptive matter, and the work has over 120 half-tone illustrations, together with maps and diagrams which show at a glance the distribution of the population, geological formation, agricultural activity, railways, canals, etc. The Editor is himself responsible for the sections devoted to railways, canal and river navigation, science teaching and technical instruction, and shipbuilding. It is cheering to observe in the midst of much industrial decadence a healthy development of railway traffic, even in the face of a decreasing population. In 1871 the total receipts from all sources of traffic amounted to £2,272,386, whilst in 1900 they reached £3,806,347, an increase of 67·5 per cent. The largest increase has been in the carriage of minerals—233 per cent.—while the passenger traffic receipts have advanced by 62·4 per cent.

> In one respect (writes Mr. Coyne), in the matter of gauge, the railways of Ireland enjoy an immense advantage over those of Great Britain. . . . Before any of the great lines were laid sufficient experience had been already gained to show that the standard narrow gauge of 4 ft. 8½ in. which had been adopted in England was too small. . . . Since 1849 the Irish railways have used for main line work the uniform gauge of 5 ft. 3 in. . . . Owing to this difference in gauge, there is always the possibility, remote though it may appear at present, that at some future time Ireland may be far in advance of the rest of the kingdom in railway development.

Comparing Irish railways with British, Mr. Coyne says:—

> The cost of the construction of Irish railways, as indicated by the amount of paid-up capital, has been remarkably low when compared with the cost of those of either England or Scotland; in fact, the average cost per mile is less than one-fourth of the cost in Great Britain. It will be seen that, though the net receipts are much lower in Ireland than Great Britain, yet, owing to the much smaller cost of construction, the average dividend for Irish railways is higher than that in England or Scotland.

In the chapter dealing with canals, the writer emphasises the importance of maintaining their efficient and unrestricted utility as independent competitive routes, and points out the evil of allowing railway companies to acquire the control of short sections of these trunk waterways, and thus effectively to interfere with competition along their entire lengths. The present condition of Irish canals is reviewed, and a sketch given of the course and development of the leading routes. Most of them were constructed early in the last century, at great cost; but they have, with few exceptions, fallen into disuse and consequent inefficiency.

The short chapter which describes the shipbuilding industry of Belfast and Londonderry speaks of vigorous growth. In the latter town the premier position is, of course, held by Messrs. Harland and Wolff, the builders of the new White Star passenger and mail steamers *Oceanic* and *Celtic*.

> Such has been the energy and enterprise of this company, that from 100 hands in 1858, the number of persons employed has increased to 9,000, and the amount of tonnage turned out by the firm during the past seven or eight years exceeds the production of any other yard in the world. In this connection the following figures are interesting. Messrs. Harland and Wolff turned out tonnage to the amount of 81,316 tons in 1896, 84,240 in 1897, 67,905 in 1898, 82,634 in 1899, 73,897 in 1900, and last year they launched seven ships having a gross tonnage of 92,316.
>
> The greatest successes of this firm are associated with the White Star Line. Indeed, the whole fleet (forty-four ships) of the White Star Company was built by Messrs. Harland and Wolff. It was for the White Star Company that the long type of ocean steamship, with saloon and first-class passenger accommodation amidships, was introduced in 1870. This, though a great advance in ship construction, is only one of the improvements due to the Belfast firm. Every demand, indeed, made by modern commercial necessities, and modern luxurious ideas, has been met by Messrs. Harland and Wolff. The world wanted big ships; Queen's Island built the *Oceanic* and the *Celtic*. Steady "railway timers" were required, and the *Majestic* and the *Teutonic* were produced. In fine, Messrs. Harland and Wolff have shown themselves pioneer builders of vessels of great size and extraordinary speed.

At Londonderry shipbuilding dates back to early in the nineteenth century, but it was not until 1886 that a proper shipbuilding yard was opened. This, however, was closed in [illegible] but in 1898 the Derry industry again showed signs of activity, when the yard was re-opened by the newly-formed Londonderry Shipbuilding and Engineering Co., Ltd., who have since built ships over 380 ft. long for several of the great steamship companies.

> One of the serious drawbacks [illegible] Londonderry is that only the hulls are constructed [illegible] either the hulls have to be towed [illegible] to Glasgow or Tyne works, for their engines, or the engines have to be brought to Londonderry. This causes considerable loss of time and money. Over [illegible] men and boys are employed, and as the industry is prosperous and progressive, the number of workers is increasing.

Though Belfast and Londonderry are the chief seats of the industry, shipbuilding is also carried on at Haulbowline, and a decided effort is being made to revive it at Dublin, where a company has been formed to carry on the work on the banks of the Liffey. A dockyard suitable for the construction of vessels up to 300 ft. long is being rapidly put into working order.

Science teaching and technical instruction are arousing a renewed interest in Ireland. As Superintendent of the Statistics and Intelligence Branch of the Department of Agriculture and Technical Instruction for Ireland, Mr. Coyne is able to give his readers a comprehensive survey of the condition of technical instruction in Ireland.

> Whilst eighteen years ago the Irish students formed 11·2 per cent. of the total number of students (including England and Wales), and their grants amounted to 14·5 per cent. of the total grants, the proportions now are only 2·3 per cent. and 1·2 per cent. respectively.

It is hoped, however, that, with the aid of a Government grant of £55,000 per annum, a great improvement on the above returns may be effected.

We strongly commend this book to the careful attention of every British manufacturer who wishes for reliable information concerning the industries and resources of the Sister Isle.

"THE AMERICAN INVADERS."

By F. A. McKenzie. Grant Richards.
2s. 6d. net.

"THE future still waits for us if we will to have it," says Mr. McKenzie in his preface; "but to hold our own there must be reform, far reaching and thorough. It is to help to bring needed changes that this book is written." The author claims to be strictly impartial in his review of British and American trade, but page after page impresses us with the fact that he has a case to make out, and a little racy exaggeration here and there lends a spicy flavour to the whole.

We notice merely with mild surprise that "we are approaching the stage when it seems that the London literary world will sit at the feet of Chicago and New York." As far as we can gather from this informing book, we have little left but the cycle trade, and but for American "cuteness" there can be little doubt but that this would have been in danger, too. It may be remembered that the Americans saw in these Islands an appropriate dumping ground for unsaleable bicycles which were unfit for use on American roads, and that the British public did not rush in and purchase.

The writer calls attention to American preparations to capture the trades of to-morrow. He says :—

> It requires little foresight to realise that very soon the trade in gas engines will increase quite sixfold. To my knowledge at least one American-English house is making careful preparation for this increase, and hopes to scoop the whole business when it comes. There is a German patent gas engine which will also stand a good chance. But one hears no rumours of British firms preparing for this boom.

Verbum sap. But we have known effective preparations made without "rumour."

We have paid dearly enough for our South African possessions. According to Mr. McKenzie, "the coming months may show that we have paid the price to benefit the traders of other lands, and that Americans especially will reap the commercial profits of our triumph in South Africa."

Although there is much matter in this work which is open to controversy, it makes interesting reading, and the author goes fully into the campaign of Mr. Pierpont Morgan and the Standard Oil group, the tobacco war, and the bid for our steel trade and shipping. A chapter of exceptional interest gives an account of the new Westinghouse Works at Trafford Park, contributed by Mr. D. N. Dunlop.

The author emphasises the pernicious effect of hampering legislation on British industries :—

> Americans are succeeding to-day largely because of their climate, their superior education, their longer

working hours, their willingness to receive new ideas, their better plant, and perhaps most of all, because of their freedom from hampering traditions.

It may be noticed that I do not say Americans are succeeding because of the great resources of their country. This, I am aware, is the common explanation. But although the natural resources of America are one of the great ultimate factors in the contest, it is yet possible to attribute too much importance to them at the present stage. England has magnificent resources, and is placed in a spot which naturally makes her a great centre of the world. Here we have iron, and coal, shipping facilities, and mineral wealth of every kind, and it is not for us to complain of the natural resources of our competitors.

What we must complain about is our bad legislation, our neglected education, our indifference, and excessive optimism. Through our bad legislation we have lost and are losing many trades. The tobacco, printing, and electric industries are instances of this. Once Ireland had flourishing tobacco plantations. These were purposely killed in order that the tobacco industry in our then American colonies might be fostered. Our erstwhile colonies are now a rival nation, but the revenue restrictions still make tobacco growing here practically impossible. There is no reason, climate or other, why Ireland to-day should not produce great tobacco crops.

In the concluding chapter the author deals with the question, "Can we meet America?" and discusses the attitude which should be taken up with regard to the so-called "invasion":—

So far from opposing the introduction of American improvements, even to the profit of the Americans in this country, we should welcome them and aid them in every way. . . . We have, it is true, to decide whether we are going to be a subordinate people, allowing the Americans to take the supreme rule of our industries, or whether we are going to retain our old chieftainship. But we will not keep our place by any other method than that of raising our industrial conditions up to those of America. Only by improving the physical growth and mental development of our people, and by putting the best brains of our nation, unrestricted by old traditions, into our industrial concerns can we hope to advance. The time when the governing classes of this country treat commerce as a matter for lofty patronage and scornful misunderstanding must go by. To-day we are hindered in a hundred ways by inadequate and pernicious laws. We see industry after industry almost throttled by mere legislative stupidity. We find our traders refused the facilities which every other progressive government willingly gives its people. We witness commerce fostered in other lands, while in England it is severely left alone.

He concludes as follows:—

The purchase outright of British manufactories by Americans is a blow to our prestige. But in many instances the American purchasers settle in our midst, and become English in their turn. England has in the past shown great power of absorbing outer peoples; in the future she will show the same. To build high barriers against Americans would be folly. If we wish to hold what America is taking from us we must do so by proving ourselves as good men as the Americans; as good in business energy, in education, in technical training, in working capacity, and in inventive skill.

"THE NEW SOUTH AFRICA: ITS VALUE AND DEVELOPMENT."

By W. Bleloch. With illustrations, maps, and diagrams. W. Heinemann.

A NEW and revised edition of Mr. Bleloch's work is well-timed. Now that we have entered into the possession of our recently-acquired territories, it is interesting to pass in review the predictions of those who undertook to speak of their latest resources, in order that we may see how far these anticipations were justified by actual fact. One of the principal objects the author had in view in writing "The New South Africa" was to convey to those who had not lived in the country, but who had undertaken a great war on behalf of its future, some idea of its natural resources.

The estimate of available gold was sufficiently high to challenge unbelief. After a year's further study, however, the author expresses confidence in the correctness of his conclusions:—

In August, 1901, and in January, 1902, the reefs were cut in the Turf Club boreholes; and although the actual assay results are not so good as might have been expected from the records of the outcrop mines, the ore bodies are of payable grade, and their continuity to a depth of nearly 5,000 ft. is conclusively demonstrated. Measuring along the plane of the reef, these results may be taken as proving the ore bodies for over 10,000 ft., of which only a very small portion has been exhausted. Apply this figure of practically two miles of dip to the ten miles of the Central Rand only, and some idea of the importance of the "strike" will be obtained. The assay results of the eastern boring indicate an extraction value of 36s. 3d. per ton for the South Reef and about 28s. 9d. per ton for the Main Reef leader, while in the western the record is not so good. Even in the richest outcrop mines poor zones are encountered (as well as conversely rich zones in poor mines), and, in any event, a core assay is no safe criterion of value of large blocks of ground. Future results will probably confirm the general average of 41s. per ton for this particular section of the Rand.

Other discoveries have lately been made which tend to show that new lines of banket reefs may be opened up, and, on the whole, the evidences are such that it may be confidently expected these new lines of reef, besides making up for any possible shortcomings of the Main Reef series, will probably swell the actual returns far beyond the great estimate given of the gold-producing value of the Rand. Vigorous exploratory work is [illegible] to be commenced on both the eastern and western extensions of the Main Reef series. In the far eastern section of the Rand, the Modderfontein Deep Levels Company struck reefs officially correlated with the Van Ryn reef at a depth of about 3,070 ft. in February, 1902.

Some confirmation as to the estimates of the Rand output in the next few years is furnished by the statement of Mr. A. R. Goldring, Secretary of the Transvaal Chamber of Mines, before the Water Supply Commission, that within five years there will be 17,000 stamps running on the Rand, turning out gold to the value of between £50,000,000 and £60,000,000 a year.

The appointment of a Commission to inquire into the working of the gold law is likely to result in such reforms as will make prospecting practically "free," and, which is equally important, inexpensive.

The Rand mining industry is making rapid advance to the position it had attained prior to the war. Milling was commenced by three companies in May, 1901, and in the table which follows are shown the monthly crushings and outputs, together with the number of stamps employed :—

Month	Companies.	Stamps	Tons Milled	Output Fine Gold	Value. £
1901					
May	3	150	15,300	7,470	31,271
June	7	350	40,111	19,779	84,014
July	7	365	46,436	25,960	110,266
August ...	7	380	47,365	28,474	120,053
September	8	414	53,187	31,936	135,654
October ...	8	440	54,908	33,393	141,848
November	10	554	67,882	39,075	166,080
December	12	653	86,811	52,807	224,702
1902					
January ...	21	1,075	143,756	70,341	298,786
February	22	1,260	158,151	81,405	345,782
March ...	29	1,540	211,727	104,127	442,303
April ...	31		–	119,588	508,000

In an informing chapter on Industry and Commerce in South Africa, the writer shows that these are handicapped by the cost of skilled labour, but speaks hopefully of the opportunities that will be afforded for establishing iron and steel works :—

The great engineering works on the Rand have been called into existence by the requirements of the mines, and might more properly be considered as part of the mining industry. They are extensive and well equipped ; some of the workshops can turn out heavy machinery well made and well fitted, and all can execute repairs, make castings, and fit in parts with efficiency and despatch. But so far the great cost of skilled labour, and other items of expenditure, have made it impossible to compete with home and American industry in machinery manufacture. When the superior iron ores of the country are worked, a change in this respect will take place, and in the course of the next decade it is fairly certain that iron foundries on a large scale will be working. Branches of the firms at present supplying the Rand with mining machinery, or others, will be established at Johannesburg or Middelburg ; the first to come will no doubt secure the lion's share of the trade.

It is more than likely that a start would have been made in this direction already, had it not been for the fact that the principal mining groups have large financial interests in one or more of the great firms making machinery for the Rand, and while the mines continue to be controlled wholly by the present people, they will naturally support their own factories ; but if new mines are opened and new capital is induced through liberal measures of Government, there will undoubtedly be excellent opportunities for establishing many different branches of iron and steel manufacture, including machinery.

In passing, it may be observed that, independently of the larger and more important uses of iron and steel in connection with the mining industry of the Transvaal, there are many requirements of the country which could be supplied immediately from Transvaal iron ores, and which offer large profits to anyone taking up their manufacture. For instance, there will be a demand for iron fencing standards, Kaffir pots, etc., etc.

The Rand Central Ore Reduction has for some time past been producing pig-iron from Middelburg ores.

The author estimates that the amount of good coal available in the Transvaal is 60,000,000,000 tons :—

The districts where the coalfields are best developed geologically, and where the best qualities of coal are found, are Middelburg and Ermelo. In these districts the percentage of good coal to the whole bulk is higher than in the other districts. A considerable quantity has already been sent to Delagoa Bay for navigation purposes, and, owing to its high heat-raising power and its low percentage of ash and sulphur, it has found a good market among the shippers. Coal for a market of this kind must of course be picked and dressed. Hitherto, too little attention has been paid to this work, and only a few of the collieries have the necessary machinery ; but as the export coal trade develops this state of affairs will be altered, and navigation coal from the Transvaal may be expected to take a high place among South African coals in the market. The rapid development of the Natal coal industry during the last few months indicates what can be done. One chief necessity for stimulating this trade is the authorisation of railways required to tap the coalfields. A railway connecting Springs with the Delagoa line beyond Middelburg would traverse the richest coalfields in the country, and the other line which was authorised before the war, that from Ermelo to Machadodorp, would open up another first-class district. Taking Middelburg as the centre, the distance to Delagoa Bay is only 250 miles. At a railway rate of ½d. per ton per mile, which should be a remunerative rate for down traffic to the coast, the freight to Delagoa Bay would only be about 10s. 6d. per ton. A halfpenny per ton per mile is the rate charged by the Cape Colonial railways for intercolonial traffic. In fact, for traffic coastwise the rate might even be reduced to ¼d. Assuming that the coal could be mined and sold at the pithead at 10s. per ton, after paying working costs and all charges, and leave a profit at that figure, the coal could be sold at Delagoa Bay at about 21s. per ton, at a rate of ½d. per ton per mile it could be sold at 15s. per ton. The ruling price at present for Natal coal at Durban is 30s., and the supply, on account of lack of railway facilities, cannot keep up with the demand. Some of the Natal coal companies are paying 10 per cent. every three months in dividends, and carrying equal amounts to reserve. The profit on Natal coal at the price of 30s. is 15s. per ton. To open the Transvaal coalfields for a profitable export trade, one of the principal necessities is an intelligent adjustment of railway tariffs. Needless to say this could not be obtained from the Netherlands Company. The great enhancement in value of coal in Europe affords the opportunity, and the new Government should leave nothing undone to develop the Transvaal coal industry. Besides the local demand in the country itself, it should become a strong competitor for the shipping trade of the Southern Hemisphere. Japan and Australia have secured the coal trade of the Far East, and South Africa is certain to have similar success in the South. The Transvaal must be energetic or Natal will get the monopoly.

The author mentions that there is an excellent opportunity for profitable coke manufacture.

Some experts have stated about Transvaal coal that it will not make good coke, that the product is too soft and too impure to be used for metallurgical purposes. But the reason for this statement, which may be accepted as true in the past, is that proper methods have never been applied to coke production in the Transvaal. In fact, the preparation of coal and its products for the market forms a branch of industry which is in its most primitive stage.

In the North of England good coke is made from vastly inferior coal to the bright coal of Middelburg. The best and latest machinery is required in the manufacture of coke as in the manufacture of anything else, and a rich reward awaits anyone who enters the field adequately equipped for the production of coke. One enterprising little company, the "Home Coal Estates," has done something in this direction with marked success. Its products are in great demand on the Rand, greater, in fact, than it can satisfy, and the trade is only in connection with the limited requirements of the mines in the smelting of gold. With proper machinery which would remove most of the impurities and especially the greater part of the iron pyrites from the coal, a tough, high-class, pure coke could be made from Middelburg bright coal, and such a coke would speedily create a market for itself. The smelting of iron, lead, and copper would be made possible, with the consequence that numerous mines possessing rich ores of these minerals would quickly be opened up. Iron foundries and steel-works would begin to appear, and a Transvaal Black Country would come into existence. This applies especially to Middelburg, Pretoria, and Lydenburg districts.

In addition to a great deal of valuable information on the gold industry, and the other mineral wealth of our new colonies, the author has much to say about the dynamite monopoly, agriculture, immigration, and the present inhabitants. The work is well produced, and from a pictorial standpoint alone will well repay inspection.

Die Schiffbauindustrie in Deutschland und im Auslande. By Tjard Schwarz and Dr. Ernst von Halle. In two volumes, with numerous tables and diagrams. Berlin: Ernst Siegfried Mittler und Sohn, 68-71, Kochstrasse. The first volume of this interesting compilation treats in an exhaustive manner on the shipbuilding of the world, and compares the strength of the shipping of the various great Powers. The second deals exclusively with the German shipping industry (naval and mercantile), and contains some instructive and detailed plans of the more important shipbuilding yards. Altogether a most useful work of reference, reflecting the greatest credit upon all concerned.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention PAGE'S MAGAZINE when you write. Manufacturers of Engineering and Electrical Specialities, etc., etc., are invited to forward for review in this column copies of their catalogues, price lists, and circulars as soon as issued.

The Allis-Chalmers Company, Chicago, Ill., U.SA. We have received from this firm a number of booklets, each dealing separately with their various specialities in mining machinery. There is abundant evidence that more than ordinary care and forethought have been exercised in the compilation of these catalogues. The master hand of the designer is apparent, and much credit is also due both to the engravers and printers for the excellent effects obtained. The very large field which is covered by this firm in the manufacture of all kinds of mining machinery is so well known that it is hardly necessary here to give even a passing notice to their many specialities. Perhaps the most interesting of the catalogues before us is a booklet of 208 pages and cover (sixth edition of Catalogue No. 3) dealing at length with their roasting, smelting, and refining machinery for the purpose of extracting gold, silver, lead, and copper from ores by igneous processes. It includes various kinds of ore samplers, grinders, and breakers, also oxidising, chloridising, roasting, smelting, and blast furaces. Altogether a very useful set of catalogues, and well worth the attention of managers and others concerned in the development of mining properties, small and great.

James Neville and Co., Springfield, Ohio, U.S.A.—Pamphlet K, of 46 pages and cover, illustrates and describes the latest types of the Samson turbine, built by this firm, and for which they claim "the finest results known to the art of turbine building." We are told that over 15,000 (or 1,000,000 h.p.) Leffel wheels are now in use, which certainly speaks well for the excellence and satisfactory working of this turbine. The plates illustrating installations at Niagara Falls, Rock Island, etc., are especially interesting.

Cole, Marchent and Morley, Ltd., Bradford.—This firm has just issued a well printed and illustrated booklet of 124 pages and cover, entitled "Condensing Equipments." In addition to the particulars usually embodied in a catalogue, there is much matter of a descriptive and pithy nature, rendering it one of the most complete catalogues hitherto published in connection with condensing and cooling. The workings of condensing plants, heaters, evaporators, cooling plants for steam power installations, pumps of various types, feed-heaters, oil-separators, water-softeners, etc., etc., are here all so lucidly explained and exemplified by illustration, that we feel sure the book will be read with avidity by those interested in this class of machinery.

The Glacier Anti-Friction Metal Company, Ltd., London.—A pamphlet of 24 pages and cover, containing a few tests and reports on Glacier Anti-Friction Metal, in which we are informed that this material has been tested and endorsed not only by engineers, railway and steamship companies, but by many Governments of the world, and there are also reprints of a few commendatory letters from customers. We are officially informed that the jury at the Exposition de Lille have awarded this firm the silver medal for their Glacier Anti-Friction Metal, this being the highest award given for anti-friction metal.

W. T. Ellison and Co., Ltd., Irlams-o'-th'-Height, Manchester.—An eight-page pamphlet describing and illustrating their principal speciality, viz., turnstiles, of which several kinds are mentioned. The exit cage turnstile calls for special notice. This is an ingenious contrivance by means of which it is possible to obtain ingress or egress only, according to its adjustment, the object being to prevent congestion at the entrances and exits to and from race-courses, pleasure grounds, football and cricket clubs, etc. As a kind of auxiliary to this catalogue there is a four-page pamphlet illustrating another of the firm's specialities—pumping machinery, the principal of which is the "Niagara Falls" double acting, pulsating steam pump, the price list of which is also given.

Thomas A. Renshaw and Co., 8, Bath Street, City Road, London, E.C. As London agents for the Universal Automatic Feed Handmill, Messrs. Renshaw & Co. have issued a descriptive pamphlet and price list of this and other machine tools, including the Taylor automatic tool grinder, universal cutter and grinder, Clark's improved boiler head flanging machine, engine lathes, built by the Goddard Machine Co., Wheeler's planers, etc., etc. Of interest to all users of machine tools.

Fuller and Co., 9, Red Lion Court, Cannon Street, E.C.—A large quarto 70-page illustrated catalogue and price list of their many specialities in electrical appliances, including the Alpha cables and wires, electric light casings, "Lux" incandescents, porcelain switches, fuse boards, resistance frames, switch boards, arc lamps, ammeters, voltmeters, and much more useful paraphernalia attendant on the application of electricity in various ways.

Mosses and Mitchell, 69-71, Chiswell Street, London, E.C. Catalogue and price list of the "Original" vulcanised fibre. This fibre, we understand, has been upon the market for over twenty-eight years. It is used largely for railway, electrical, and general mechanical purposes, and possesses peculiar qualities which render it entirely different from any other known material. In an interesting description of its manufacture we are told that a certain prepared vegetable fibre is treated with "powerful chemical agents," then submitted to very heavy pressure and brought to practically a homogeneous condition, after which the chemicals are extracted, and by means of "an extremely delicate chemical process" it is converted into the substance known as "vulcanised fibre." The purposes to which the material can be applied seem to be almost unlimited, and one of its peculiar qualities is that of electrical insulation.

Atlas Tool Works, Levenshulme, Manchester.—The latest catalogue to hand from this firm is a booklet containing some fifteen leaflets with reproductions of their principal specialities—lathes, radial, horizontal drilling and boring machines, slotting, planing, and milling machines, and vertical turning and boring mills. The catalogue as a whole is excellently designed and printed, but we venture to suggest that better effects could be obtained from the blocks of photos 64 and 65 by the exercise of a little more care on the part of the printers. This, however, is only a detail.

The Empire Engineering Co., Failsworthe, near Manchester. A pamphlet of 20 pages and cover illustrating, by means of excellent half-tone engravings, their various specialities in Lubricators (the "Sight Feed," "Empire," "Piston," "Compact," "Simplex," "Boss," "Rex," and "Drip"), Safety Valves ("Dwarf," "Pop," "Empire," "Empire Spring," etc.), Steam Driers ("Stemtriff," etc.), the "Empire" Steam Trap, and Asbestos-Packed Water Gauges. The last named are made of best gun-metal and are tested to 300 lbs. per square inch.

The "Harris" Patent Feed-Water Filters, Ltd., 2, Hamilton Street, Greenock. A 16-page pamphlet containing a short treatise on Feed-Water Filters and their use as applied to boilers, also various sectional drawings and half-tone blocks, and a list of some 250 vessels—including men-o'-war of many countries, liners, merchantmen, steam yachts, etc., etc.—to which the Harris Feed-Water Filters have been fitted. Two large blocks representing H.M.S. *Terrible*, and the *Campania* and *Lucania* are especially interesting.

The C. W. Hunt Co., of New York and Staten Island.—Catalogue No. 029, containing 20 pages and cover, profusely illustrated by half-tone blocks of the first quality, the excellent effect of which is heightened by the superior art paper on which the catalogue is printed. The booklet is entitled "Hunt Cable Railways for handling Coal and Merchandise," and deals at length with the three varieties of Cable Railways manufactured by the firm. The first is called the "Heavy Cable Railway," which is operated as follows: The steel cable is kept constantly in motion and the cars are attached at will at any point, and are drawn around the tracks by the cable until the grip is released. Secondly, there is the "Double Shuttle Cable Railway" in which two cars are used—one going out loaded and the other returning empty, passing each other on a switch, or on a double track. Thirdly, there is the "Single Shuttle Cable Railway," in which one car only is used—being drawn by power outward to the dumping point, automatically dumped, and then drawn back to the loading point. The manufacture of all the necessary appurtenances for these railways is undertaken by this firm—including driving engines, cars of all kinds, rails, tracks, etc.—and we are told that "no Waltham watch or Baldwin locomotive is more carefully designed, the detail more thoroughly studied, or the materials more carefully selected and worked into shape than are the working parts of the Shovel, Elevator and Automatic Railway."

J. H. Williams and Co., Brooklyn, New York. An excellent little brochure of 76 pages and cover, containing some more than ordinarily fine illustrations from interior and exterior views of their works and manufactures in iron, steel, copper, bronze, and aluminium drop forgings, including air valves, wrenches of various types, automobile parts, starting levers, thumb nuts, screws, wire rope sockets, ammonia union forgings, dies, crank shafts, handles, collars, and many others. This firm are the sole makers of the Vulcan brands of drop-forged specialities; and annealing, tempering, and case hardening are done to order. Pages 62 to 65 of the catalogue are devoted to a telegraphic code of words (supplemental to the ordinary standard codes used) for their principal specialities.

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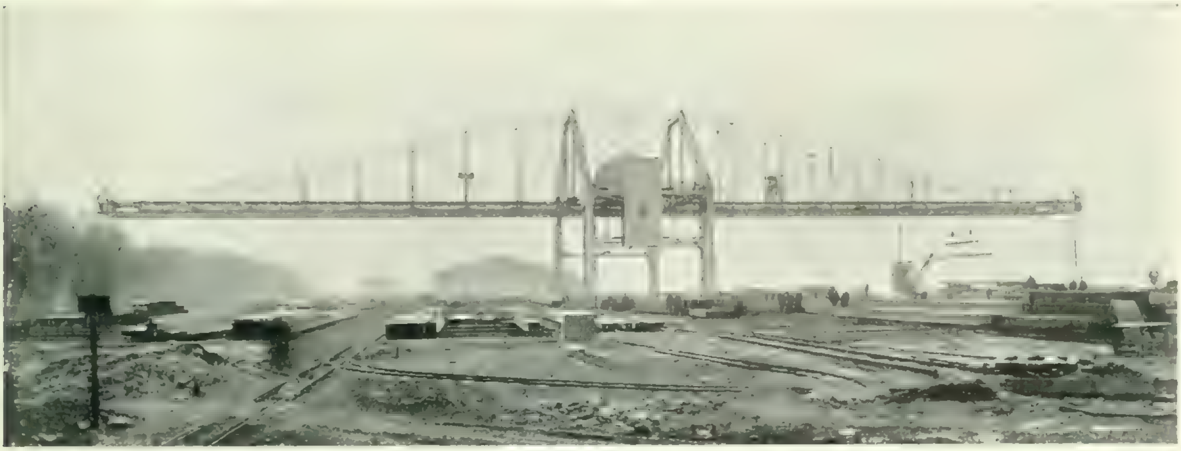

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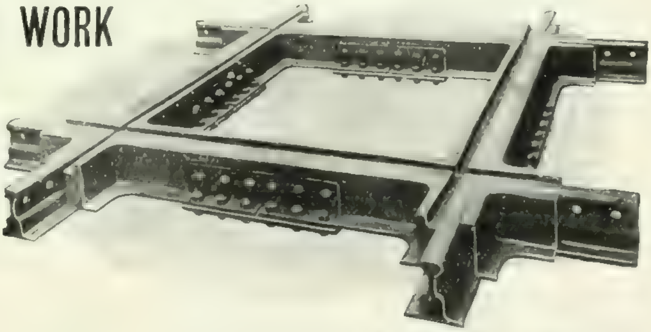

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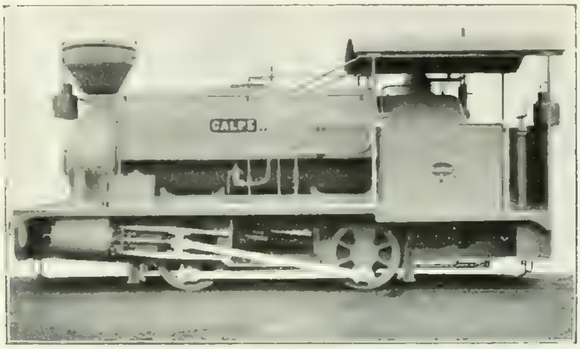
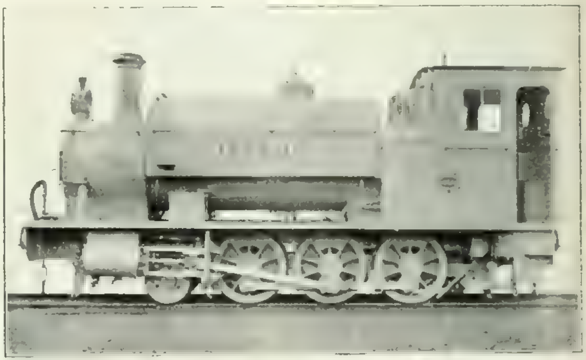


Cyls. 10in. X 16in. Gauge 3ft. 3⅜in.



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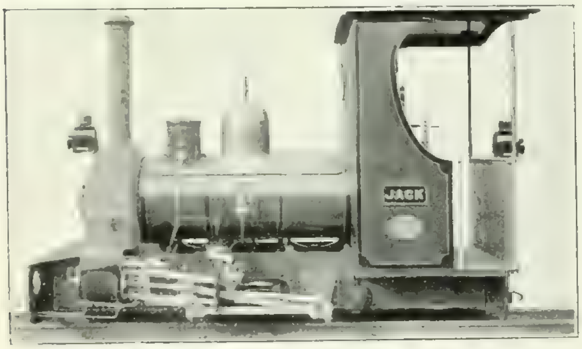
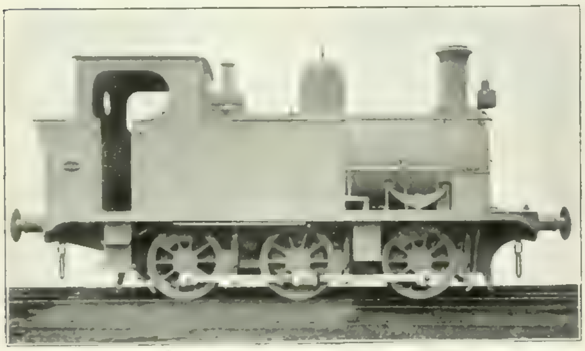


Cyls. 6in. X 8in. Gauge 1ft. 6in.

Cyls. 8in. X 12in. Gauge 2ft. 5½in.



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"OPIFICER, LONDON."

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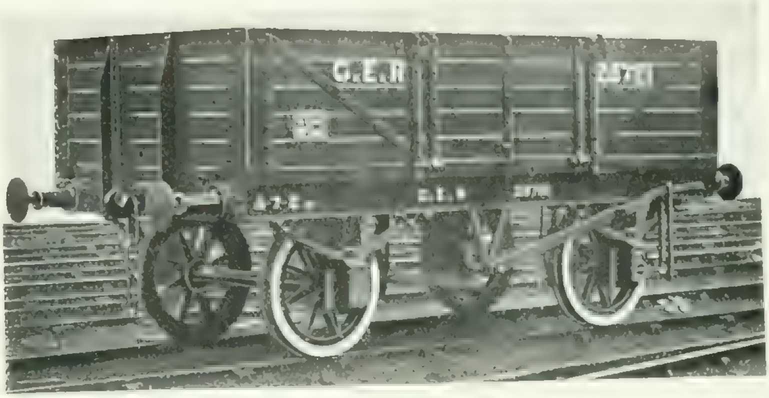
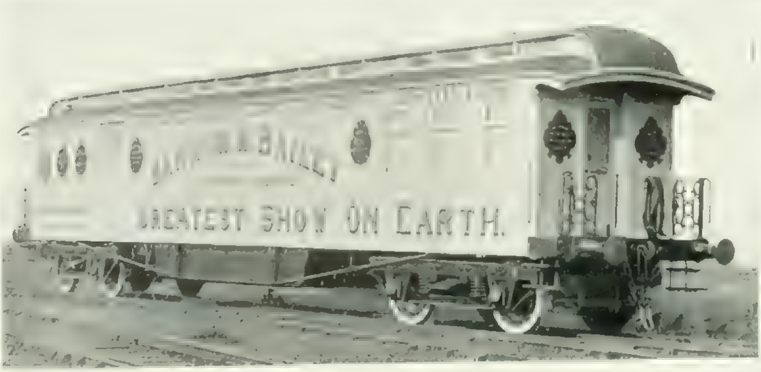


One of 750 Steel Frame Goods Wagons built for Great Eastern Railway Company.



One of 70 Special Vehicles constructed for Barnum & Bailey's Show. These have run on all the principal British and Continental Railways.

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LONDON OFFICE:
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E.C.

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LTD.,

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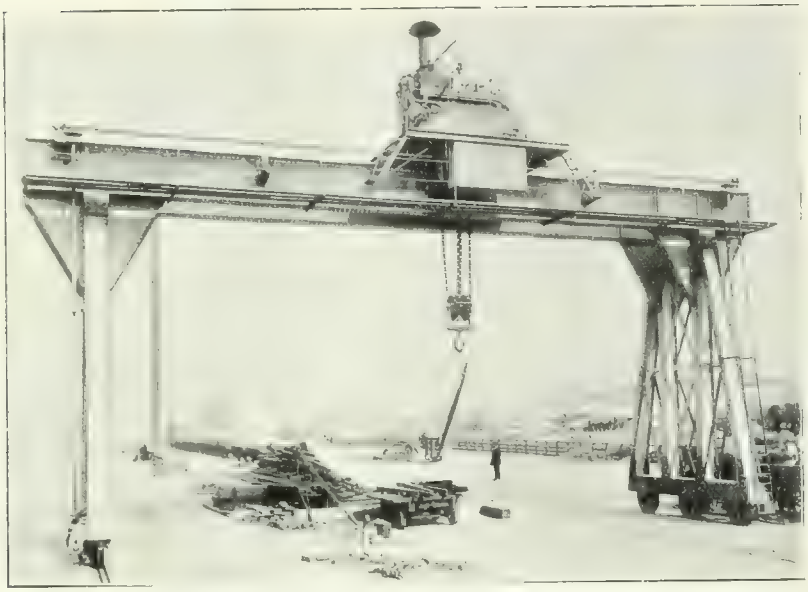

40-ton Steam Goliath Crane at the new L. & N. W. Railway Goods Yard, Sheffield.
And also supplied to Midland, Lancashire & Yorkshire, and Great Western Rys., &c.

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Cranes, Winding Engines, Overhead Travellers of Every Description, Driven by Steam, Electricity, or Hydraulic Power.

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THOMAS HILL & CO.,
66 and 68, Robertson St.,
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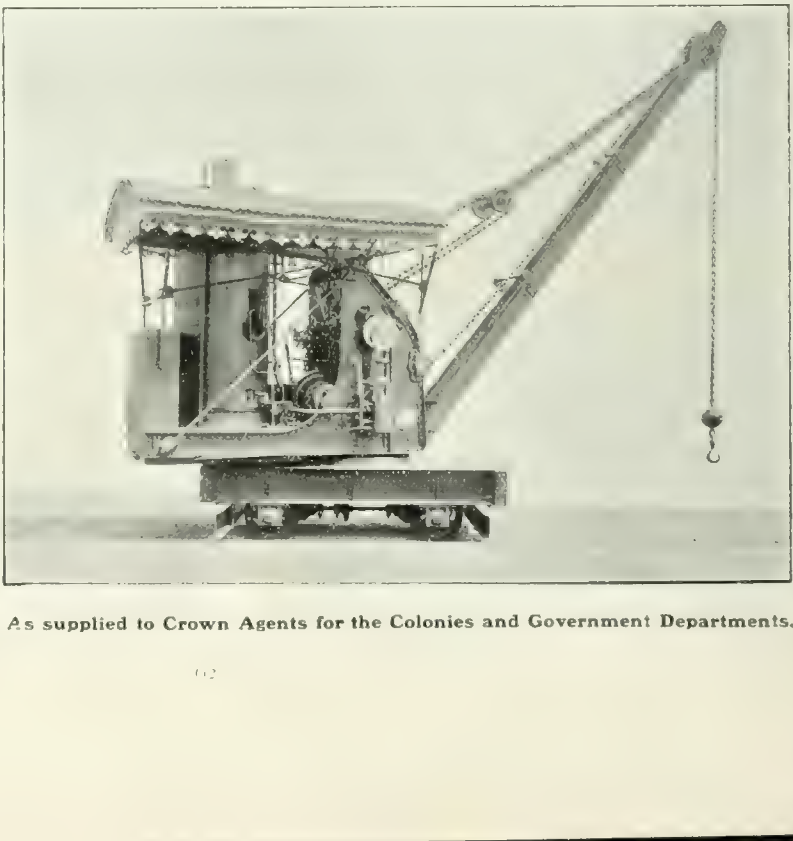
Telegrams :
"CRANES, RODLEY."
"ASUNDER, LONDON."
"SPECIFY, GLASGOW.



As supplied to Crown Agents for the Colonies and Government Departments.

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SUITABLE FOR ANY GAUGE.

Lowest Tare.

Greatest Capacity and Strength.

Smallest Number of Pieces.

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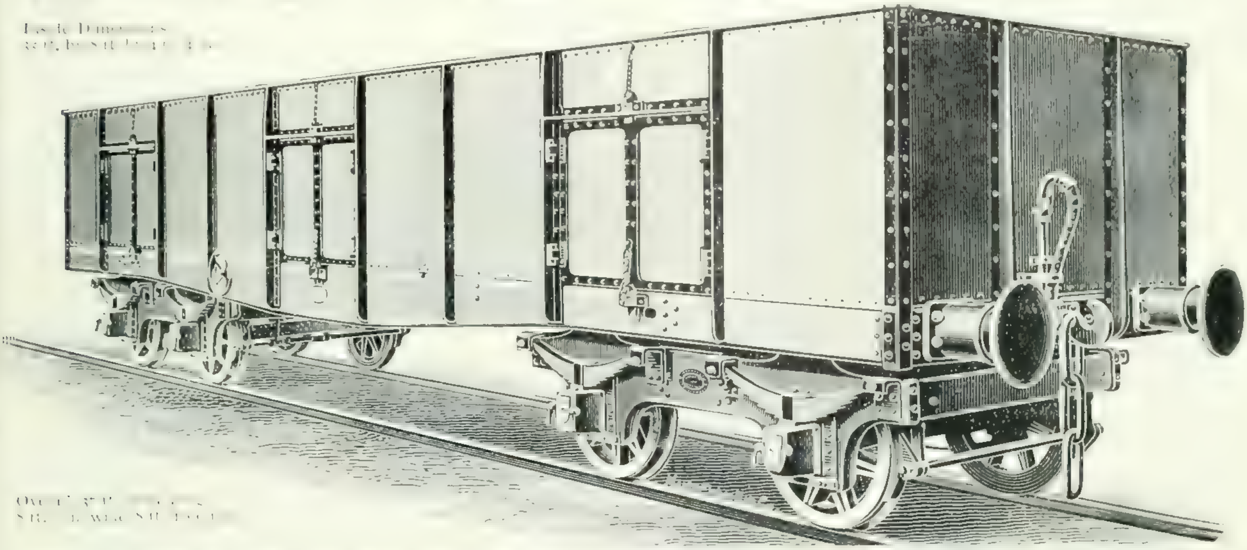
Write for Further Particulars.



[illegible] Ton All Steel Bogie Coal Wagon, Tare Weight 12 tons [illegible] cwt. [illegible] Capacity [illegible] cubic ft. Actual Test Load [illegible]

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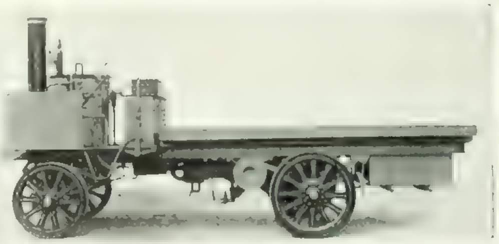
Makers of all kinds of Steam Vehicles for Commercial Purposes, Lorries, Vans, Drays, Municipal Tipping Dust Vans & Water Wagons. Loads from 1 ton to 7 tons.

ALL HIGHEST AWARDS SINCE 1898.
TWO MORE GOLD MEDALS AT LIVERPOOL TRIALS, 1901.
AWARDED FIRST PRIZE (£500) IN WAR OFFICE COMPETITION OF MOTOR LORRIES.



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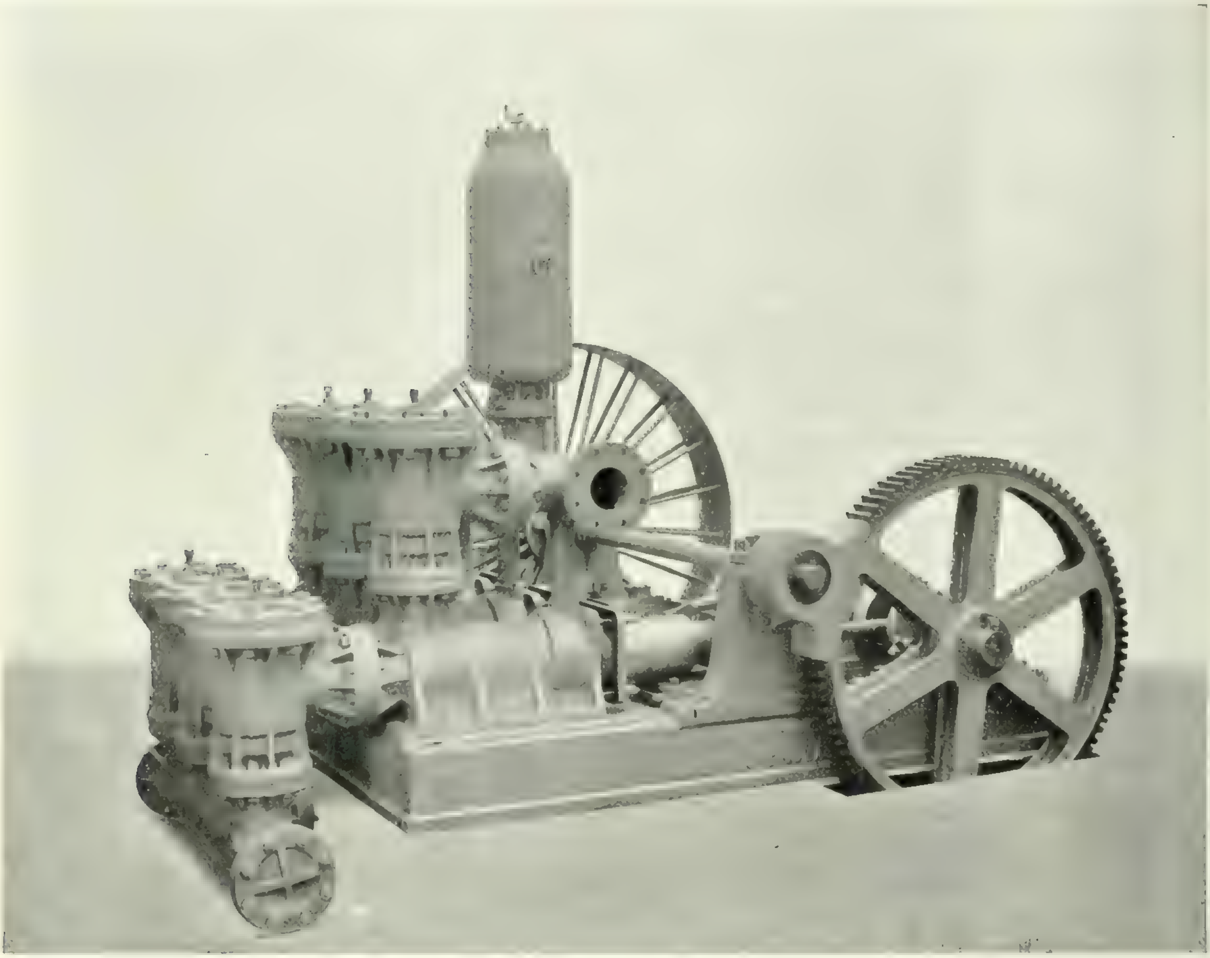

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DO YOU WANT A PUMP?

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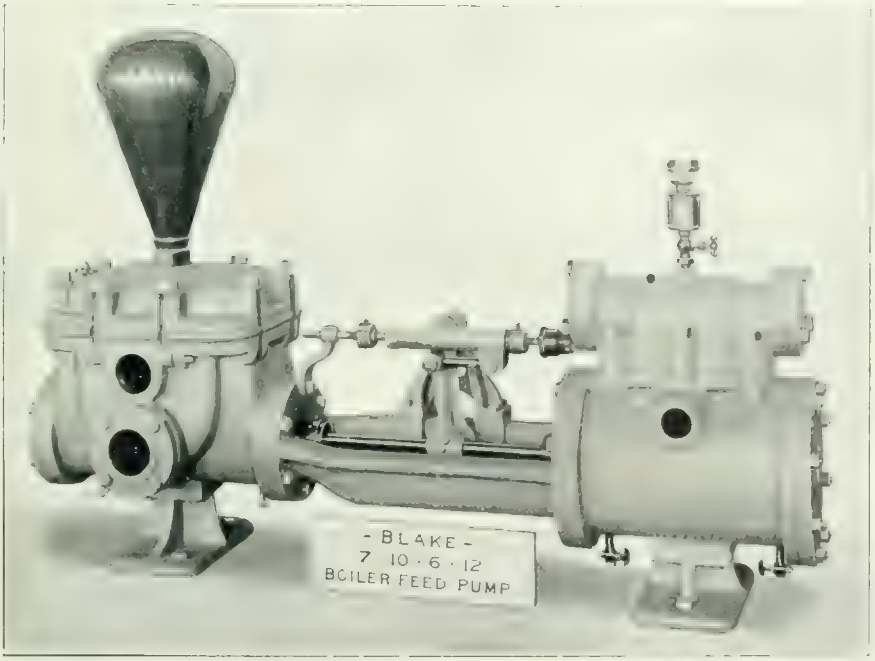

WE MAKE PUMPS OF EVERY DESCRIPTION AND OF EVERY SIZE.

CATALOGUE AND PRICES ON APPLICATION.

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The DE LAVAL PATENT.

Steam
Turbines,
Turbine
Dynamos,
Turbine
Pumps &
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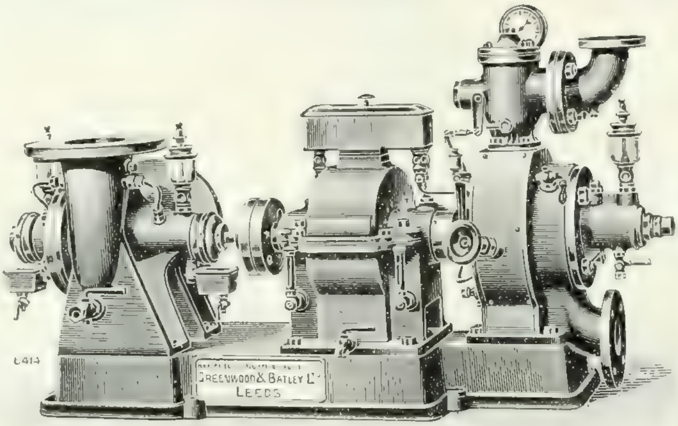

No. 6414. De Laval Patent Steam Turbine Pump. 5 B.H.P. Type B P

Machines in Use
2,402.
H.P. 71,786.
Made from
1½ H.P. to
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Dynamos
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Motors.
Light and
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GREENWOOD & BATLEY, Ltd.,
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TURBINES

Of all descriptions, and suitable for all kinds of work, such as driving Dynamos, . . Pumps, Mills, Fans, Compressors, &c.

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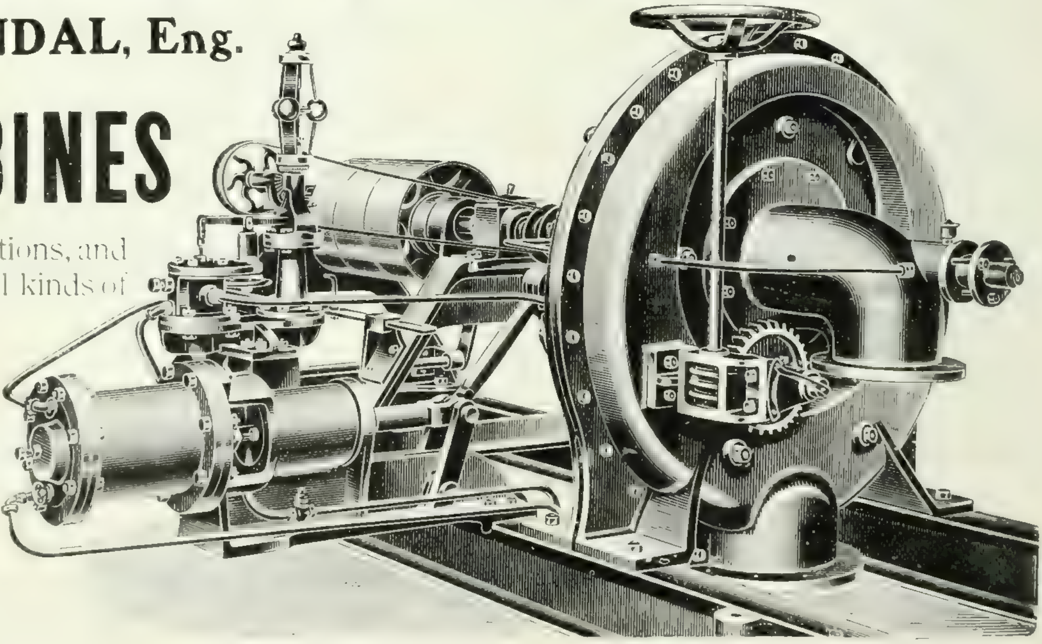
on application.



Vortex Turbine with Hydraulic Governor, Balmoral Castle Installation, as supplied to Her late Majesty Queen Victoria.

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Capital fully paid up: 60 000 000 Marks

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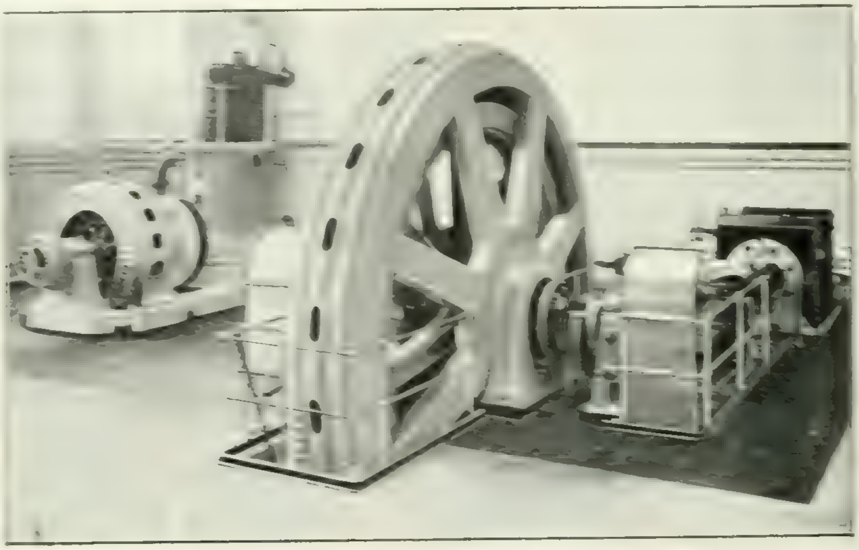

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Maximum reduction with minimum loss by evaporation.

90,000 h.p. operating in Great Britain.
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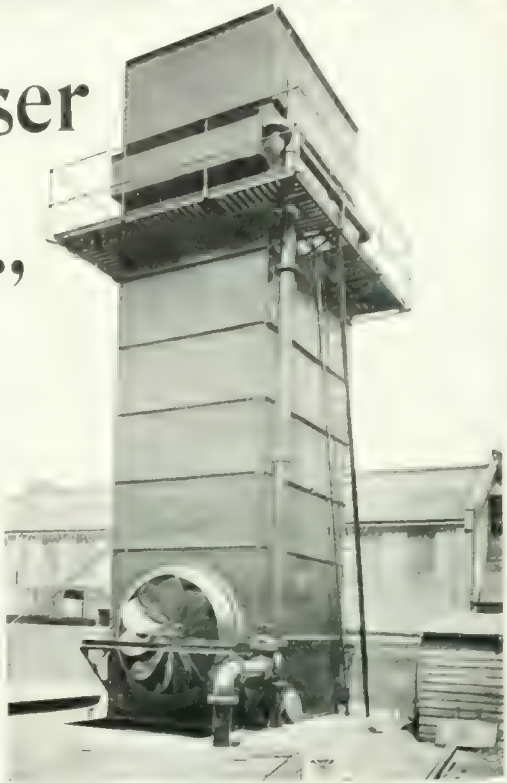

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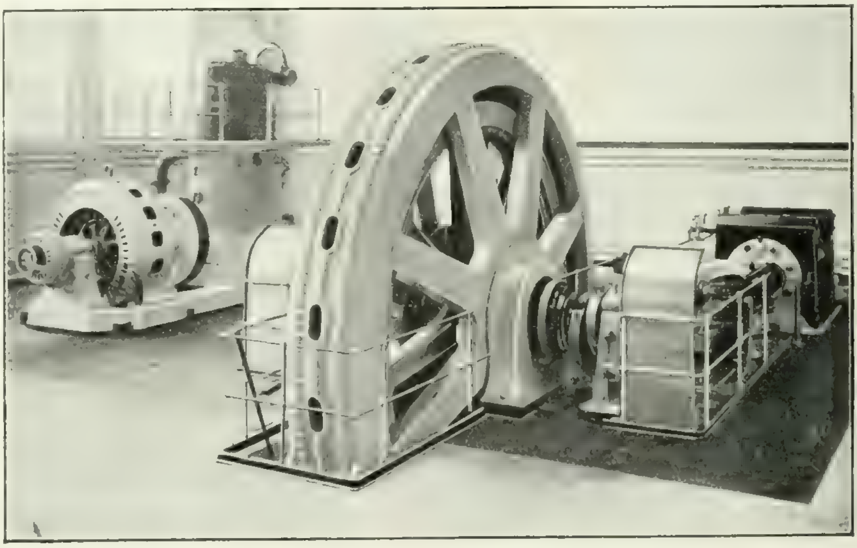

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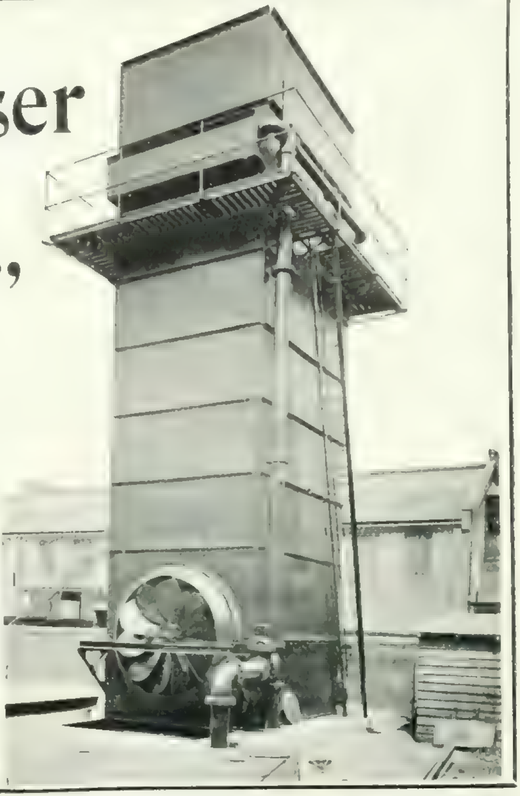

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LEAD-COVERED CABLES
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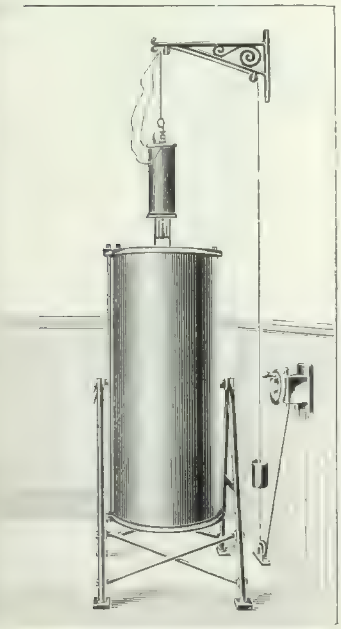

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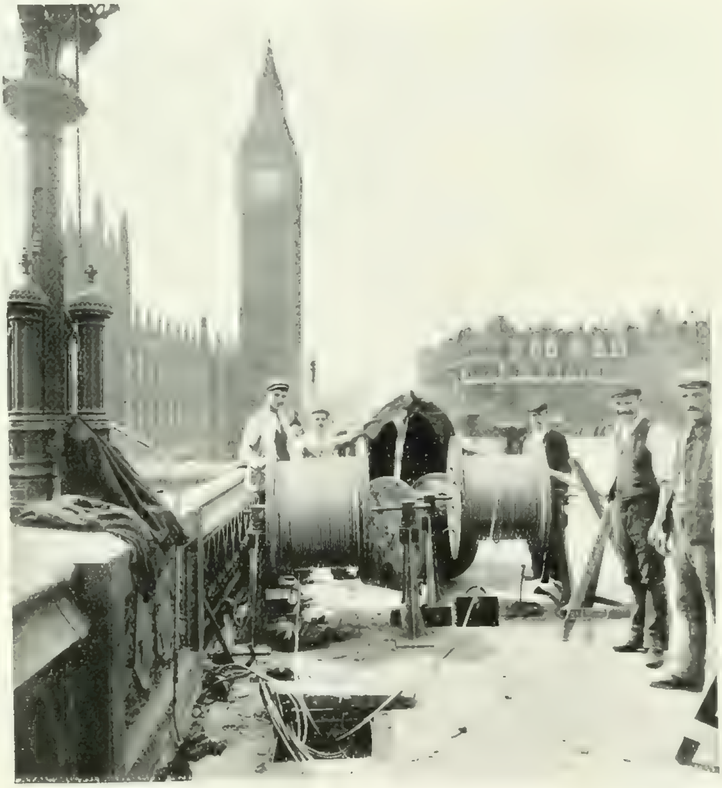

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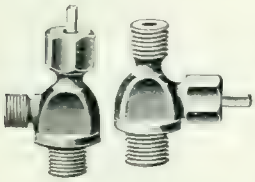

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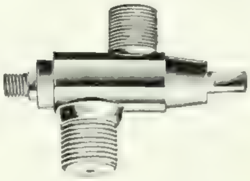

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8, ALBERT SQUARE,
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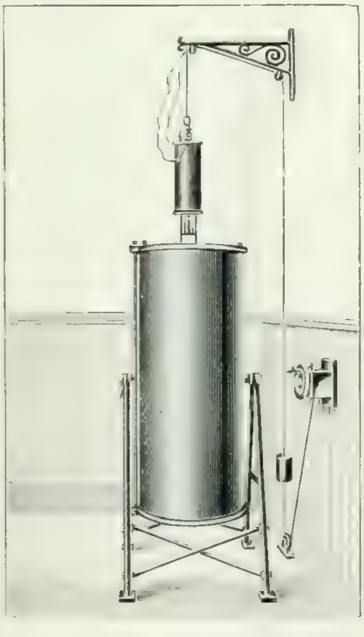

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E. [illegible]
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To stand any test or
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MADE BY THE
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**Vertical
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SPECIALITY. Boilers fitted with Deighton's Patent Corrugated Flues give 20 per cent. increased heating surface over ordinary flues.

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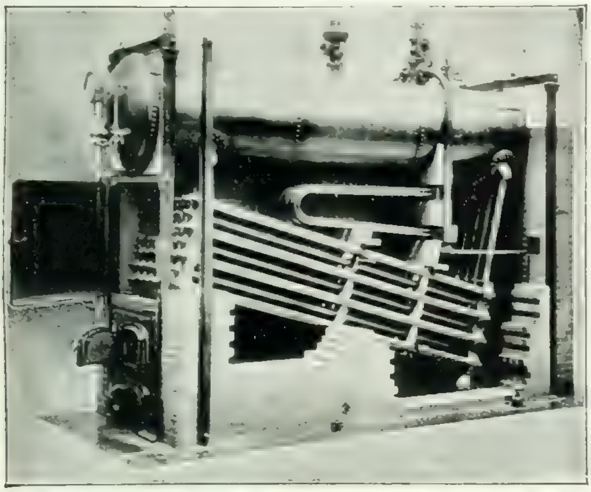

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Perfectly dry steam.
The generation of superheated steam at a controllable temperature.
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Reduction of wear and tear in the boiler owing to the avoidance of unequal expansion and contraction strains.

APPLICABLE TO ALL STEAM BOILERS.

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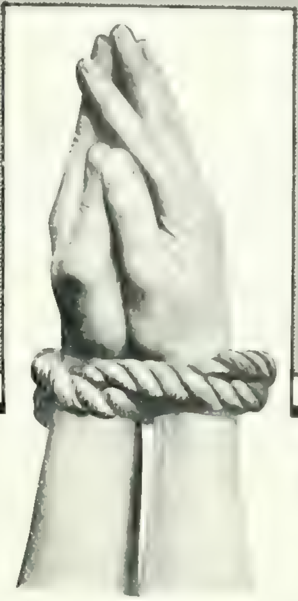

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By the opposition and prejudice of a short-sighted municipal policy in the matter of refuse disposal—a policy which involves burking the question, doing the work in the most unsatisfactory manner, and losing opportunities of saving the rates?

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The Meldrum Destructor goes to the root of the matter, effectually disposing of the refuse once and for all. Not merely eliminating the undesirable, it conserves the valuable residue, and proves at once an indefatigable scavenger and money-maker. Wideawake corporations are using the surplus heat for steam power in their electric light and tram departments.

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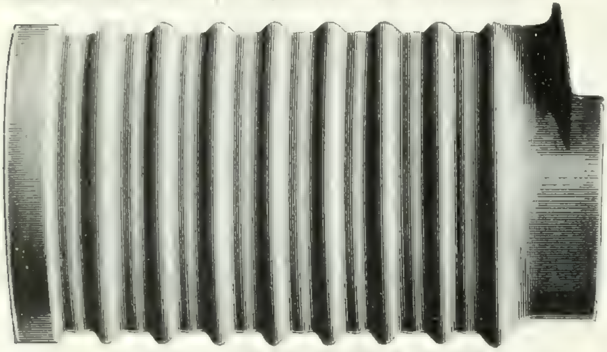
Telegrams: "FLUES, LEEDS." Telephone National 1671. A1 & ABC Codes used.



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The Destructive Tests have proved the DEIGHTON FURNACE to be the strongest to resist collapse ever made.

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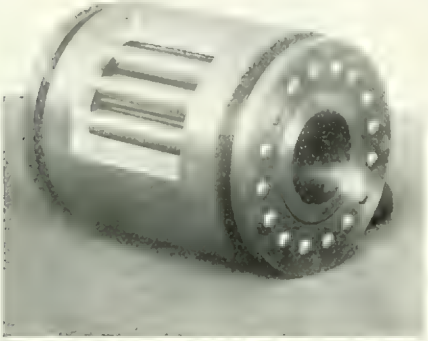

The Roller Bearing complete with part of Outer Bush cut away disclosing Rollers.

"Auto" Roller Bearings

FOR MOTOR-CARS, LORRIES, TROLLEYS, TRAMCARS, CRANES, AND OTHER MACHINERY.

SAVING OVER PLAIN BEARINGS.

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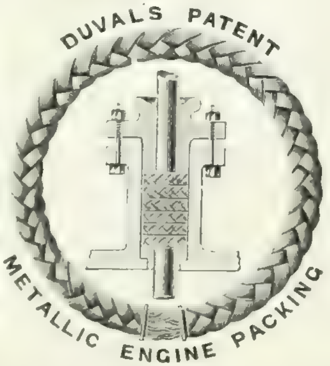
39, VICTORIA ST., LONDON.



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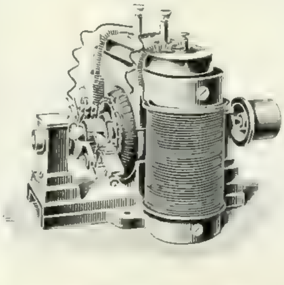

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The IMPROVED HORSFALL DESTRUCTORS
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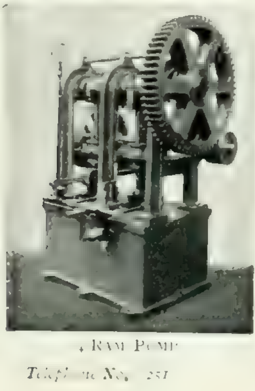

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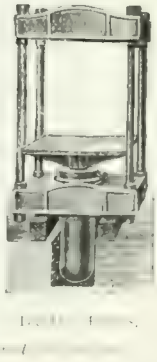

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Improved Patent Friction Clutch.

(A CLUTCH FOR ALL DRIVES.)

HUNDREDS OF REPEAT ORDERS. THOUSANDS WORKING.

OVER 200 OF OUR CLUTCHES SUPPLIED TO **ONE** FIRM ALONE.

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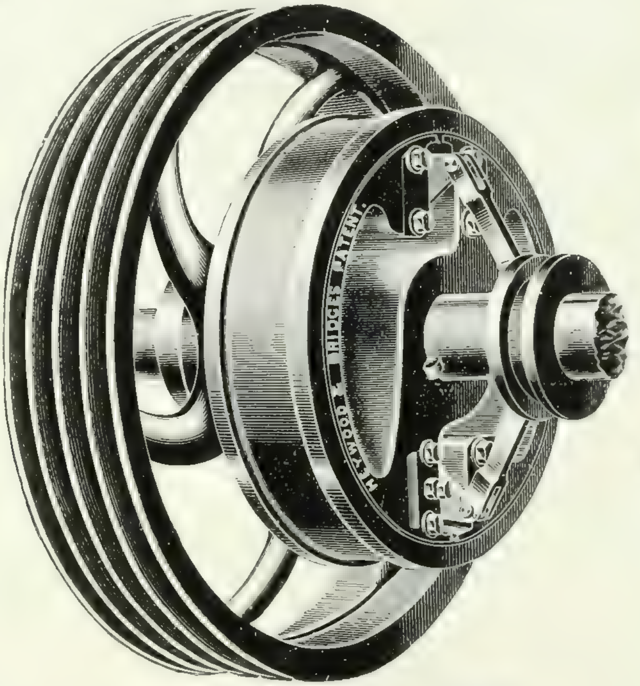
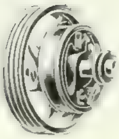
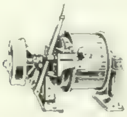



General Drive.

Speed Cone.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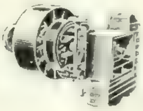
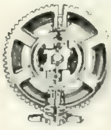
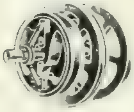

[illegible] Drive.


In Halves.


Heavy Hauling.

[illegible] **the main shafting is kept in motion.** [illegible]

[illegible] required, but may be the means of avoiding serious accident by permitting any attendant to instantly stop the main shafting or machinery. Their superiority over the usual claw couplings, taper cones, inferior clutches, etc., renders them specially applicable for connecting and disconnecting separate machines from the main shafting: for instance, those classes of machinery of which it is an essential feature that they can be started and stopped either gradually or instantly without the slightest shock or jar. Full details on [illegible]

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Machinery

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Of every possible description.

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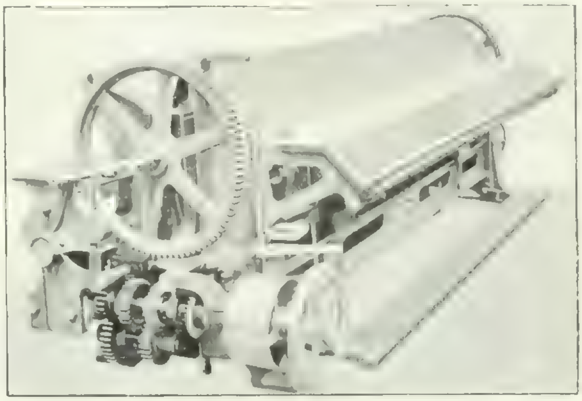
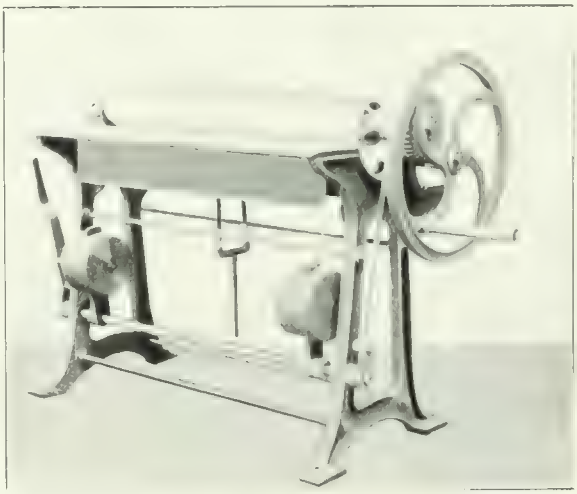
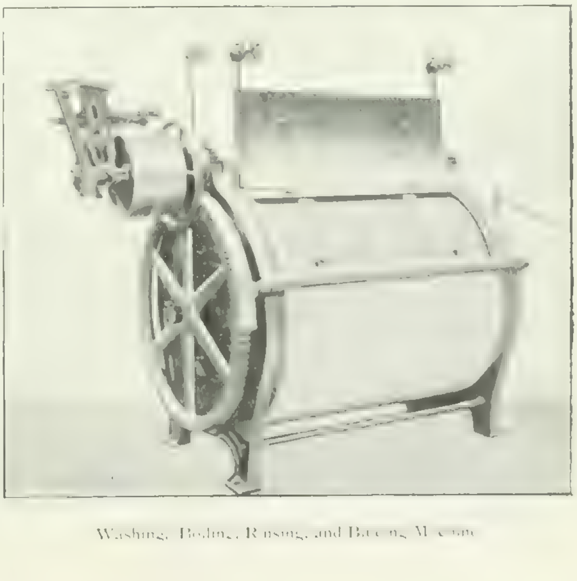


Ironing and Finishing Machine



Ironing Machine



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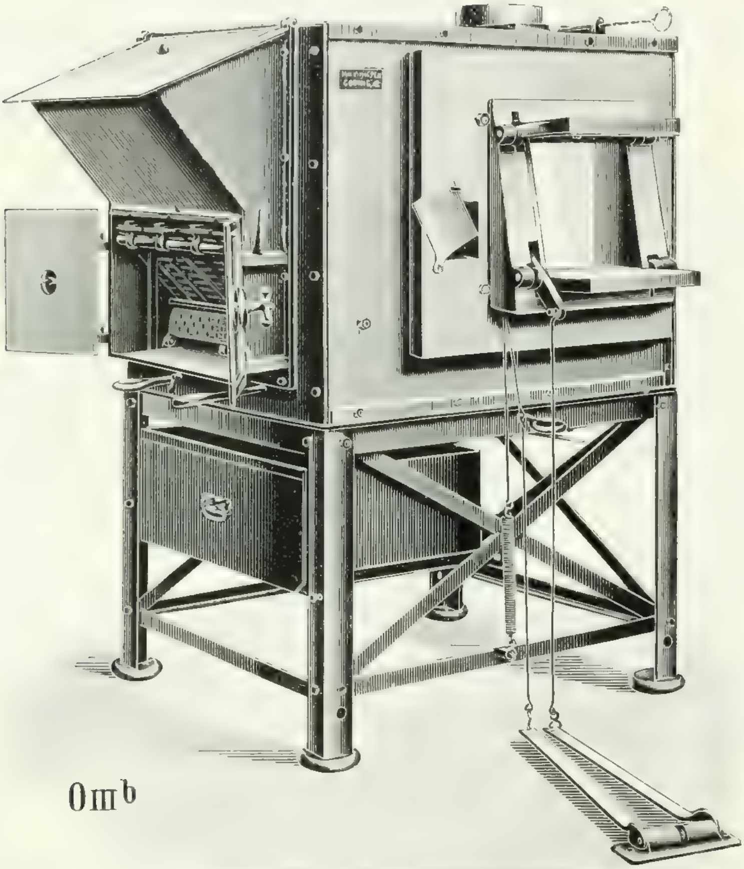

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Furnaces.

For **COAL FIRING** without BLAST, with one or more Fire=proof muffles (R), completely shut off against gases and cold air. Complete uniform heating of the steel to be hardened. Easily handled. Low cost of maintenance.

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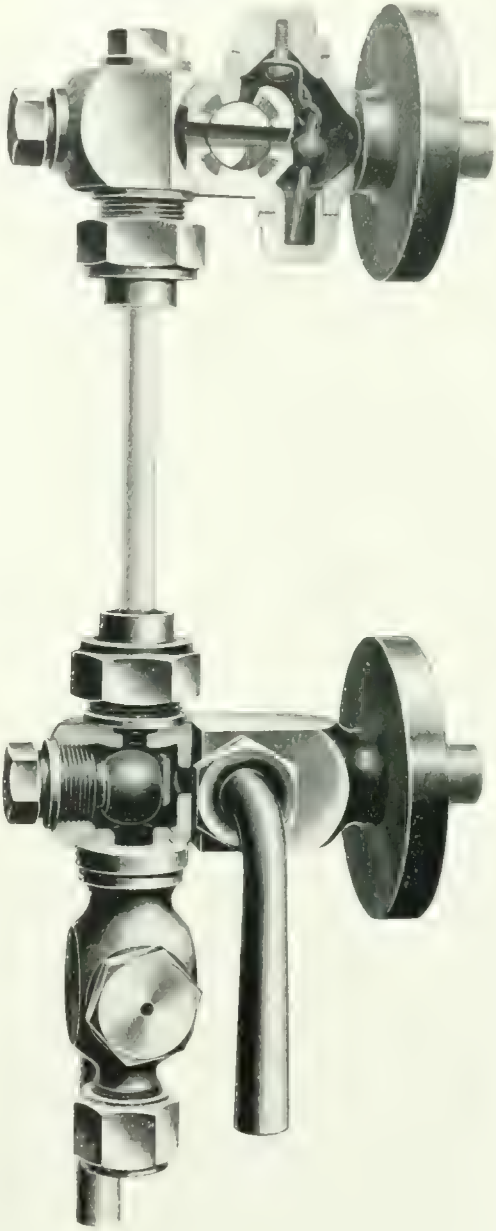

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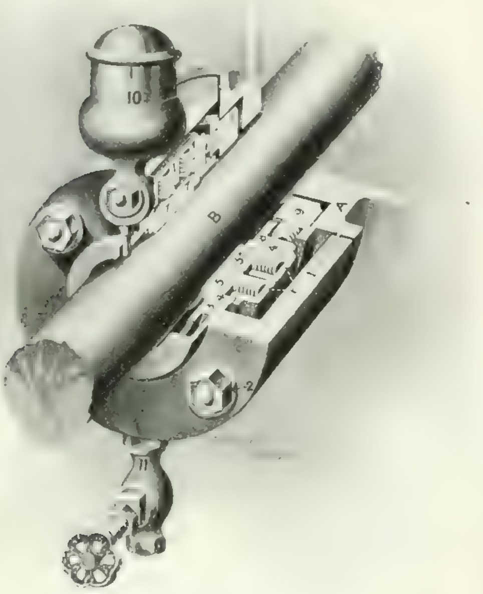

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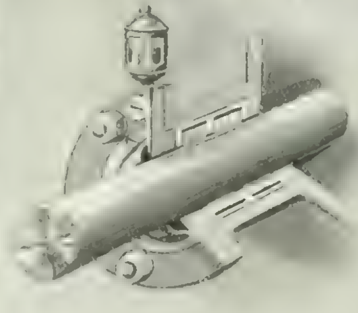

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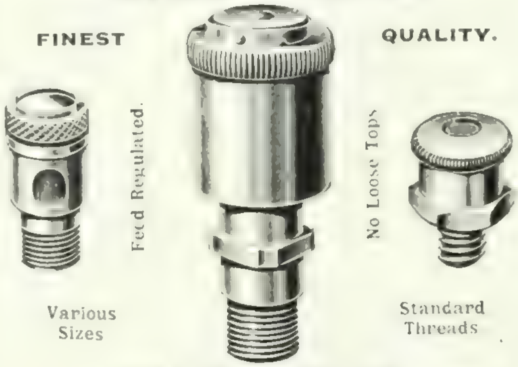
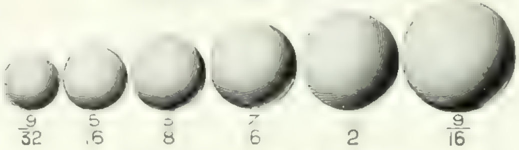


BEARING BALLS.



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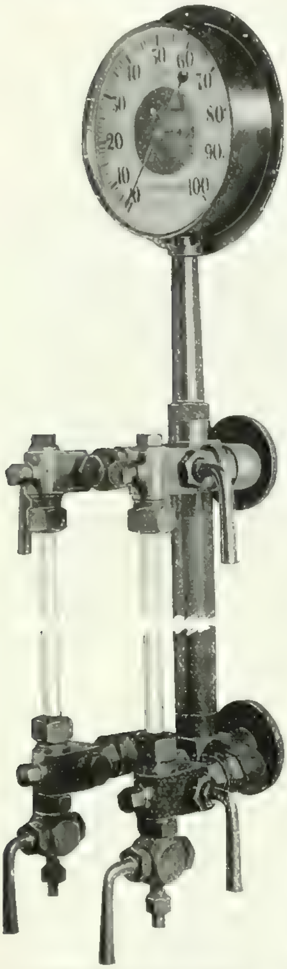

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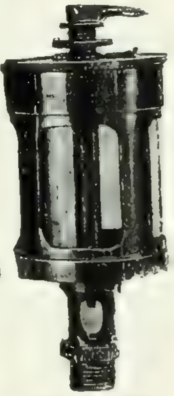
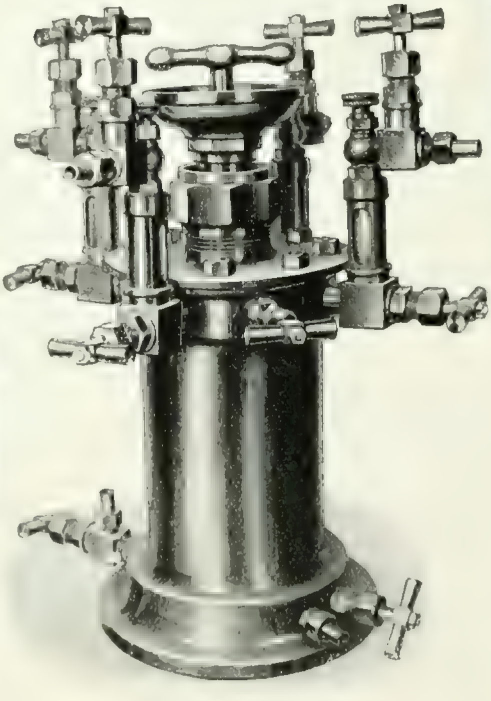


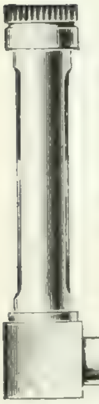
Sight Feed Oil Syphon

Centrifugal Crank Pin Oiler.

Sol[illegible] Oil Cup



Steam Cylinder Grease Cups



Oil Gauge [illegible]
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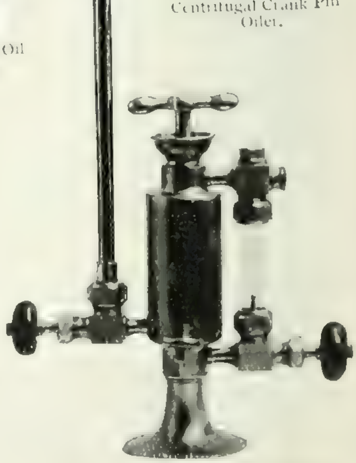

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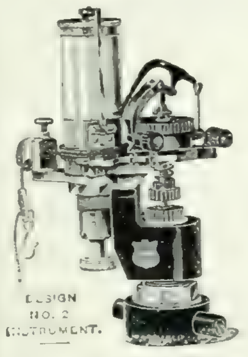

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EXTERNAL PRESSURE SPRING TYPE.

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In Two Types:—
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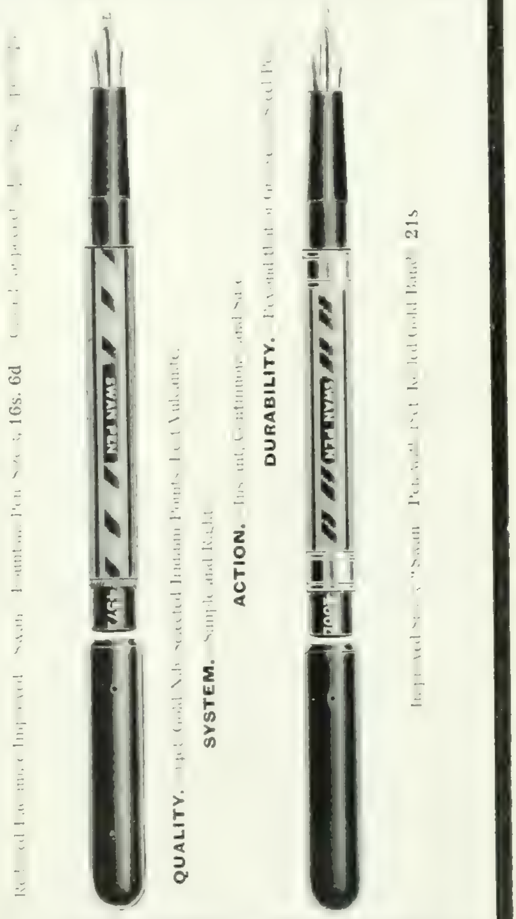

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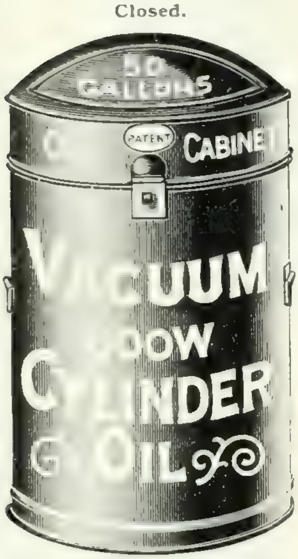

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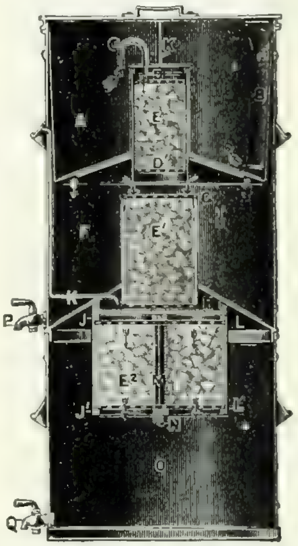

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47

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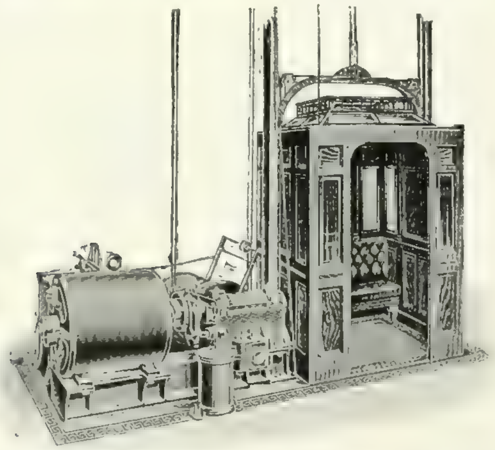

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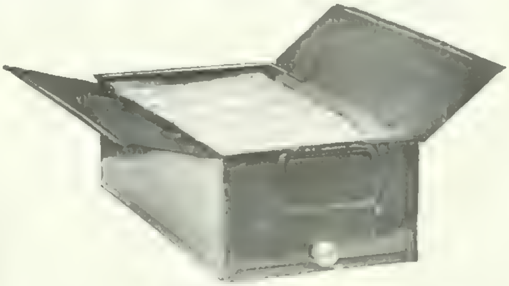

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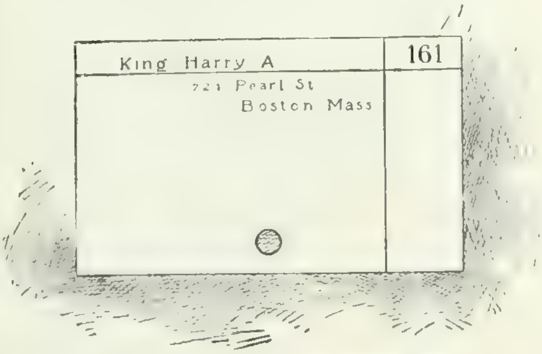

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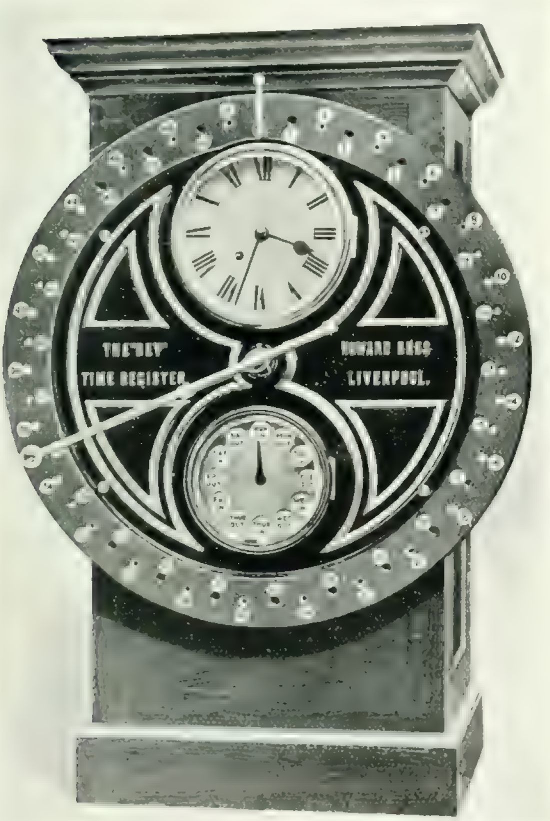

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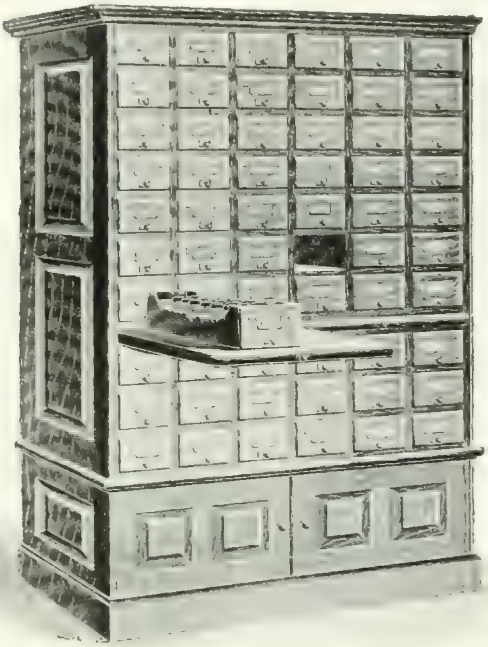

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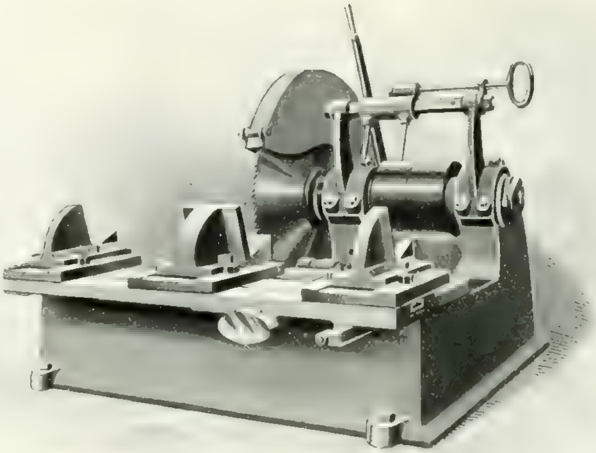

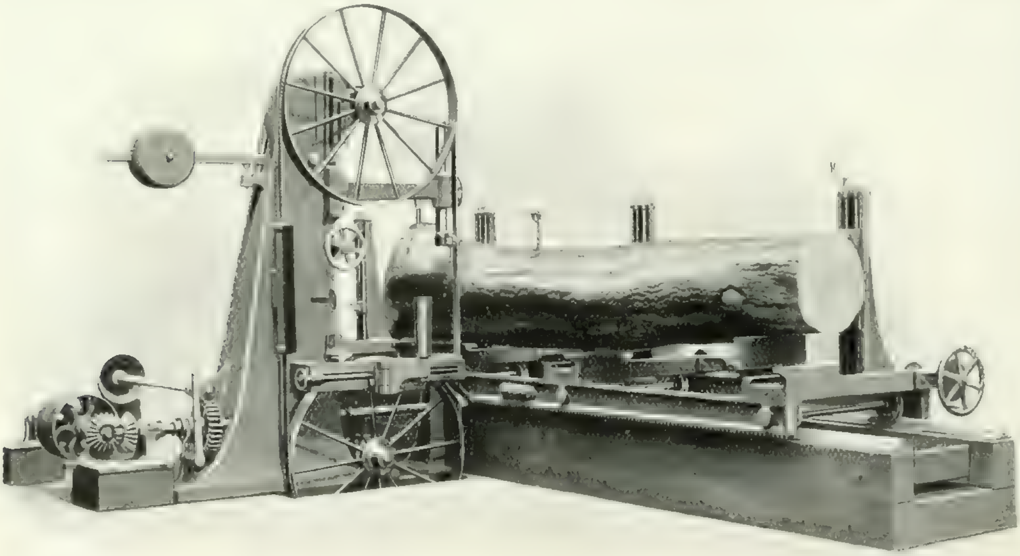

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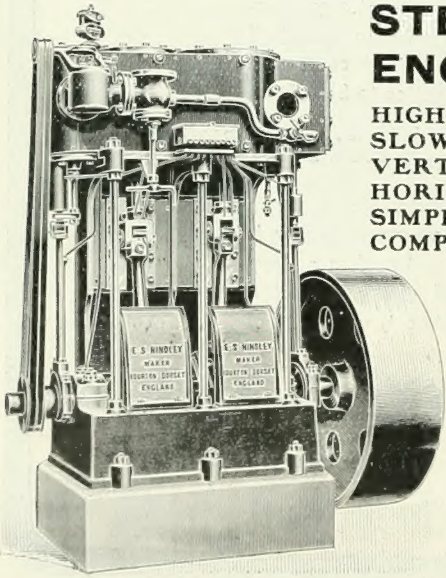

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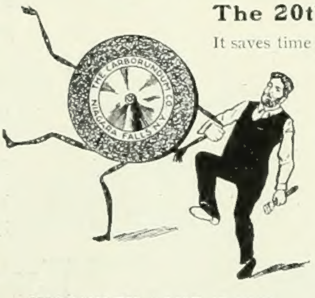

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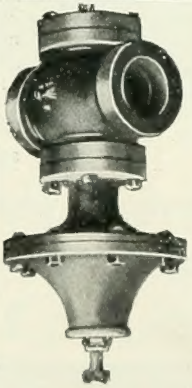

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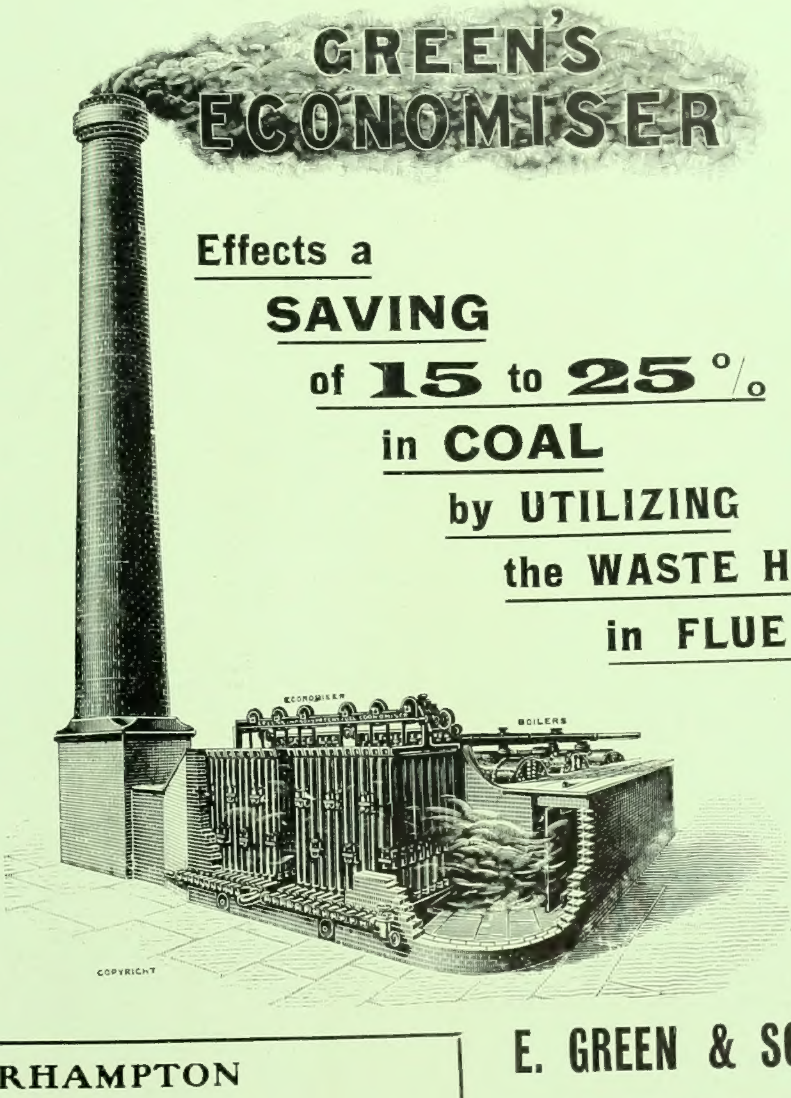

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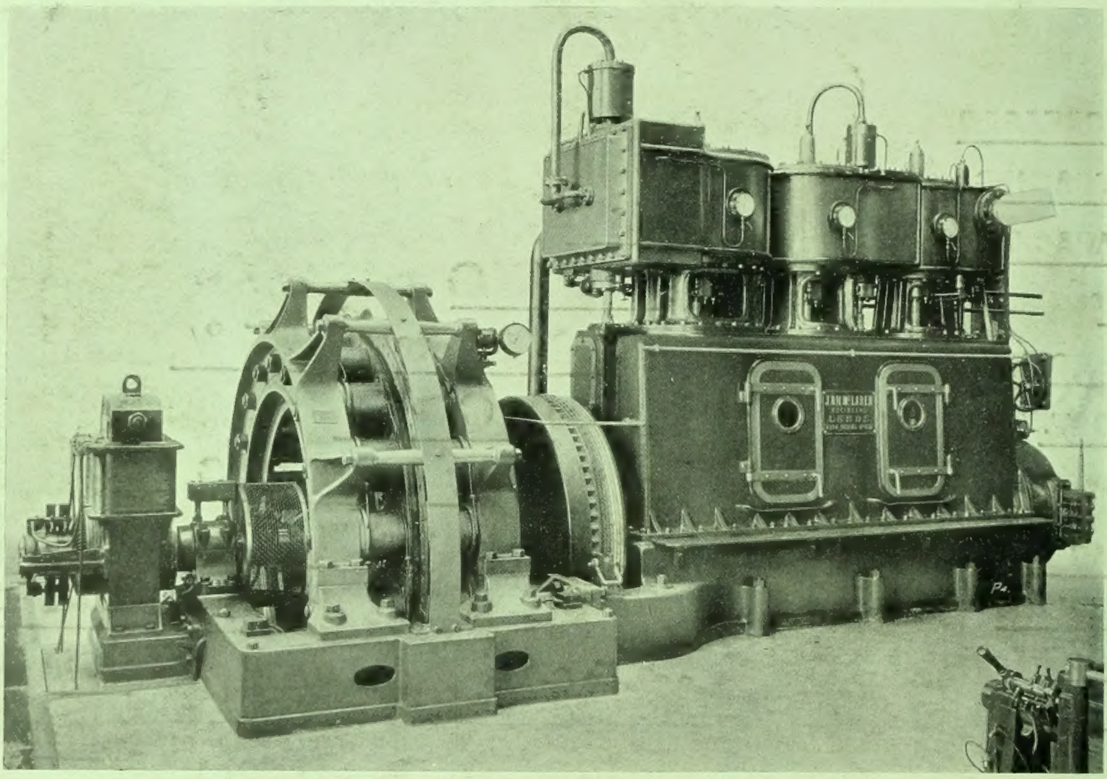

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